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THE VARIABILITY OF THE COLORATION IN THE PERCH (PERCA FLUVIATILIS, PISCES, PERCIFORMES) FROM THE RIVERINE LAKE SLAPY (CENTRAL BOHEMIA)

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Abstract. The sample of 600 specimens of the common perch, *Perca fluviatilis* (Linnaeus, 1758) from the riverine lake Slapy is analysed with regard to the coloration (regarding the number and the arrangement of oblique cross side dark bars). 21 types have been found and their frequency and the relationship to the sex are discussed

MATERIAL AND METHODS

All single samples were obtained from the riverine lake Slapy by the use of seining during 1988 and 1989. Collected specimens had the size ranging from 65 – 192 mm of the body length The main seining places were near Nova Živohošt and Ždáň. All specimens were conserved immediately after catching in 4 % formalin and during the next month the type of coloration was studied. All specimens were measured and in most also the sex was determined by section. The number of dark cross bands was counted separately on the left and right body side Bars were classified as non-ramified ones (type "a"), ramified ones (type "b"), in the form of "V" or "Y". Each specimen was listed following the number of ramified and non-ramified bars on the left body side into *relevant type of the coloration. The summary see* Plates I and II, Figures A-V * The dark spot on the head of some specimens was not reckoned

RESULTS AND DISCUSSION

It is not possible to enumerate here all literary sources where the typical coloration of the common perch with dark bars is mentioned; a list of some authors is presented by Švátora (1986) The most important is the fact that the variability in the number of bars has been known for a very long time (see e.g. Bloch, 1784). The maximal range of the number of bars is 5 – 9 (e.g. Gronow, 1854; Frič, 1908; Sabanejev, 1911; Berg 1949). The color of bars can be brown, brownish black, dark green, dark blue, sometimes they can change into irregular spots (Bloch, 1784; Berg, 1949) In some specimens it was observed that cross bars diminish *in* the very dark basic coloration of the body; see observations of V. V. Volodin in Berg (1949). In the picture of the perch in the work of Marsigli (1726) the dark bars are also not marked. Sometimes also yellow or gold colored aberrations of the common perch were observed (Grote, Vogt, Hofer, 1909). Figures A – V* present basic types of the arrangement of bars on the left body side in the perch inhabiting the Slapy riverine lake with the following frequency and representation according to the sex:

A) males 109 – 182 mm BL (ave 145 mm), n = 105; females 102 – 188 mm (ave 142 mm), n = 107, without sex determination 65 – 138 mm (ave 89 mm), n = 27

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* Plates I and II (Figures A – V) will be found at the and of this issue.

B) males 115—189 mm (ave. 143 mm), n = 105; females 101—188 (ave. 148 mm), n = 77; without sex determination 72—136 mm (ave. 92 mm), n = 36
C) males 96—170 mm (ave. 145 mm), n = 21; females 123—185 mm (ave. 150 mm), n = 22; without sex determination 68—100 (ave. 81 mm), n = 11
D) males 110—132 mm (ave. 124 mm), n = 5; females 115—180 (ave. 151 mm), n = 8, without sex determination 68—96 mm (ave. 84 mm), n = 4
E) males 110—142 mm (ave. 130 mm), n = 8; females 115—175 mm (ave. 145 mm), n = 2; without sex determination 69—80 mm (ave. 76 mm), n = 5
F) males 122—163 mm (ave. 138 mm), n = 10; females 130—165 mm (ave. 143 mm), n = 5
G) males 115—152 mm (ave. 130 mm), n = 5; females 120—138 mm (ave. 129 mm), n = 5
H) males 113—160 mm (ave. 131 mm), n = 4; female 127 mm; without sex determination 120 mm, n = 1
I) males 120—135 mm (ave. 128 mm), n = 3; females 100—175 mm (ave. 148 mm), n = 4
J) males 100—145 mm (ave. 120 mm), n = 3; female 136 mm
K) males 142—173 mm (ave. 160 mm), n = 3; without sex determination 100 mm, n = 1
L) males 122—130 mm (ave. 126 mm), n = 2
M) males 103—130 (ave. 117 mm), n = 2
N) females 136—140 mm (ave. 138 mm), n = 2
O) male 95 mm
P) male 192 mm
R) female 160 mm
S) male 130 mm
T) female 140 mm
U) female 163 mm
V) male 131 mm

As regards the relationship of the type of the arrangement of the bars according to the sex, no difference were found (see the similarly frequent representation of males and females in the dominant types of bars A and B). In the Slapy riverine lake these types of coloration (A and B) formed more than 76% of the whole sample.

By comparing the type of bar's arrangement on the left and right side of the body at 32% individuals differences were found in the order of rank of ramified and non-ramified bars. In 14% the difference in the number of bars of both sides was confirmed. It is probable that in other localities some other arrangement of bars can exist, because among the data of the common perch scattered in the literatur I have found the arrangement of bars not found by me in my material from the Slapy riverine lake (e.g. in Sabanejev, 1911; Hensel, Holčík, 1972; Hrabě, *Oliva, Opatrný*, 1973; *Vostradovský*, 1975; *Maitland*, 1977; Sedlár et al., 1989). The same type of the arrangement of bars as in the perch from Slapy riverine lake was found on photos and data in Balon (1966), Terofal (1978), Müller (1983), **Rass** et al. (1983).

SUMMARY

The observations concern types of the arrangements of cross bars on the body side in 600 individuals of the common perch, *Perca fluviatilis*, from the single locality, the riverine lake of Slapy (Central Bohemia). 21 basic types of arrangement of cross bars are described, types A and B (see the Figure) are most frequent (more than 76% of the sample). The number of dark cross bars (brownish green or brownish black ones) ranged between 5—9. No differences in arrangement and number of bars between sexes were found. In 32% differences in the arrangement of bars (the order of rank: non-ramified and ramified bars) on both sides of body were found, in 14% there were differences in the number of bars (± one bar) on both body sides.

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EVALUATION OF THE GROWTH OF THE CRUCIAN CARP (CARASSIUS CARASSIUS, PISCES: CYPRINIDAE) IN SOME LOCALITIES IN CZECHOSLOVAKIA AND POLAND

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Abstract. The length and weight growth of 1141 specimens of the crucian carp (*Carassius carassius*) from five Czech and two Polish localities was studied using the scale method. The growth rate was compared on the basis of the growth parameter Rp. In the small natural pond Malá Arazimova the growth rate was slower than in the ponds and in the Věstonice riverine lake due to the overfishing in the first locality. The exponential character of the length growth was confirmed by the Bertalanffy's growth equation.

INTRODUCTION

The crucian carp *Carassius carassius* (Linnaeus, 1758) is far from being popular among sport anglers. Due to the fact that it is a food competitor of the carp, it has not been the subject of a detailed investigation. The ecology of the crucian carp was studied, e.g., by Blažka (1957), Čihař (1957), Dyk (1956), Libosvárský (1963), Oliva (1957, 1963), Zawisza and Antosiak (1961), Žukov (1965), Berg (1949), Sloka (1959, 1960).

MATERIAL AND METHODS

The major part of the fish material was personally collected from the Labe natural pond Malá Arazimova (near the village of Čelakovice), the Jevany pond Jan (SE of Prague) and a pond in the village Kroučová near Nové Strašecí (west of Prague). For the seining the various types of hauling nets were used, 40 meters long and 3 meters deep with a meshes of size 8–10 mm and a 1 m² hoop net with 10 mm meshes.

The hauls were performed during the day in September 1978 (107 specimens), the material was acquired through the kindness of Dr. J. Novák, on October, 2nd, 1984 (117 sp.), on May 9th, 1985 (59 sp.), on May, 24th, 1985 (90 sp.), on May, 31st, 1985, (96 sp.), on June, 7th 1985 (33 sp.), on June, 15th, 1985 (23 sp.), on July, 6th, 1985 (55 sp.), on July, 25th, 1985 (48 sp.) on September, 28th, 1985 (65 sp.), on October, 3rd, 1985 (31 sp.); on May, 14 th, 1986 (26 sp.) on May, 23rd, 1986 (37 sp.), on June, 9th, 1986 (54 sp.), on October, 7th, 1987 (51 sp.). The total number of crucian carps caught in Malá Arazimova was 892 specimens.

The area of the Malá Arazimova natural pond in the inundated area of the river Labe is 286 m², its volume represents 261 m³, maximum depth is 1.75 m (Oliva, 1957, Lellák, 1953; Hrbáček, 1962).

From the pond Jan (in the vicinity of Kostelec nad Černými Lesy), a part of the Jevany pond chain, were obtained 21 specimens on April, 27th, 1978. The area of the pond is 4 ha, maximum depth is 2.5 m.

Out of the 0.5 ha pond in the village Kroučová (west of Prague) we personally collected, on October, 27th, 1984, 99 specimens of crucian carp.

Crucian carps from the Věstonice riverine lake, a part of the Nové Mlýny riverine lake system on the river Dyje, were collected on June, 6th, 1985, by Dr. Šebela and kindly donated by Dr. Lusk. On the whole we obtained 69 specimens.

We have acquired 7 crucian carps from a pond in the village Vykáň near Český Brod. The crucian carps were collected by Dr. Oliva on December, 29th, 1953. The locality was described by Oliva (1959); the area is 4,200 m², maximum depth is 0.75 m.

From Poland we obtained crucian carps from the locality of Jasień near Gdańsk, out of a natural peat bog pond with an area of 600 m², half of it overgrown with Juncus. 29 examples were collected by Dr. O. Oliva in 1961. Further 14 examples were collected from the locality Karczemki Kielpińskie in the vicinity of Gdańsk. In 1960, Oliva collected 10 specimens of crucian carp in natural ponds in the delta of the Wisla, to the south of the former main stream of the Wisla near Górki Wschodnie in the vicinity of Gdańsk.

In all specimens the length of the body was measured (longitudo corporis, standard length, SL), in a part of the sample also the weight was determined. The age was determined on the basis of the scale structure by the use of the projecting apparatus Documator Lesegerat DL II, using the 17.5 times magnification. In all specimens the ventrodiagonal radius of the scale was measured. The Rosa Lee's method was used with the correction value of 19 mm. The back calculation of the weight was performed using the method following Rounsefell and Everhart (1960). The length growth evaluation was made by the growth parameter Rp after Závěta (1989). Also the index of the population growth rate (which can be calculated by averageing the growth characteristics) and the index of population linear growth intensity calculated by averageing the relative increments were used (Balon, 1964). The length growth was expressed by Bertalanffy's equation (after Ricker, 1975).

RESULTS AND DISCUSSION

The length growth

Malá Arazimova natural pond

In 1978, 107 specimens of four age classes were studied. The smallest specimen from the first age class measured 73 mm, the longest (155 mm) was enlisted into the fourth age class. The 2nd age class (63 %) was the most frequent; then followed the third age class. Results of the length growth are summarized in Table 1.

In 1984, 117 specimens were examined, which belonged to the I and II age classes. The most numerous was the first age class (98 %). The smallest specimen in the first class measured 53 mm, the largest in the second age class 61 mm. Results of the back-calculated length growth are summarized in Table I.

On May 9th, 1985, 59 specimens of the first age class were studied. On the average, the body length was 49 mm, the back-calculated length growth was 42 mm.

The material from May, 24th, 1985, included 90 specimens, which belonged to the I—II age class. The most frequent, with 88 specimens was the first age class. The maximum body length of 71 mm was measured in a specimen from the second age class, the smallest body length, 49 mm, in a specimen from the Ist age class. The back-calculated body length of crucian carp reached 51 mm in the first year of life, and 69 mm for the second year of life.

The catch on May 31st, 1985, 96 specimens were studied. In the sample a classes O—II were represented, length groups were within the range of 39—59 mm. The back-calculated length was 43 mm in the first year of life, and 57 mm in the second year of life.

On June 6th, 1985, the growth analysis was performed in 33 specimens. The sample included the 0—IInd age groups. The back-calculated body length was 37 mm (for the first year of life) and 47 mm (for the second year of life).

On June 15th, 1985, 23 specimens were acquired, the catch of the crucian carps including the Ist—IInd age groups. The body length at the time of capture was 54 mm (the Ist class) and 59 mm (the IInd class). The back-calculated body length reached 46 and 57 mm in the first and second year of life, resp.

Table 1. The length growth of the crucian carp in the studied localities

Locality	n	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}
Malá Arazimova 1978*	107	46	84	126	147						
Malá Arazimova 1984	117	45	57								
Malá Arazimova 1985	724	42	53	57							
Malá Arazimova 1986	117	40	46								
Malá Arazimova 1987	51	37	48	62							
Kroučová pond 1984	99	53	77	98	112						
Jan pond, Jevany 1978	21	35	57	88	118	133					
Vykáň pond, 1953	7	35	54	78	107	124					
Věstonice riverine lake, 1985	69	43	70	100	127	150	170	186	202	215	231
Jasień by Gdańsk, Poland 1961	29	32	45	61	86						
Górki Wschodnie by Gdańsk Poland, 1960	10	30	43	53	69	82					
Karczemki Kielpińskie by Gdańsk Poland, 1961	14	33	46								

* Unpublished data by dr. J. Novák

Table 2. Comparison of the length growth of the crucian carp from Czechoslovak localities

Locality	n	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}
Svatuša pool, 1958, river-basin of Bodrog, (Libosvárský, 1960/1; 1963)	26	22									
Svatuša pool, 1956 (Libosvárský, l. c.)	97	23	35	50							
Lubná pool (Oliva and Hruška, 1955)	4	24	34	42							
Bačka pool, 1958 river-basin of Bodrog (Libosvárský, l. c.)	118	26	45	63	87						
Karasí tůň, natural pond (Čihař, 1957)	262	29	38	47	59	69	78	91	108	117	128
Pavlovo arm of Bodrog (Libosvárský, 1960/1; 1963)	50	29	44	55	75	83	98				
Trebišov pond (Oliva and Hruška, 1955)	2	30	51								
Černá tůň, natural pond by Čelákovice, (Oliva and Hruška, 1955)	16	32	55	71	106						
Bačka pool, 1956 (Libosvárský, l.c.)	77	33	50	77							
Kolín, pools by river Labe (Oliva and Hruška, 1955)	3	34	42	59							
Leles pool, river-basin of Bodrog (Libosvárský, 1960/1; 1963)	148	36	55	68	100	119					
Přítlucká jezera, pool, river-basin of Dyje (Libosvárský, 1960/1; 1963) near village Přítluky, 1957	15	45	57	72	78						
Zaječské jezero, pool by Nové Mlýny, river-basin of Dyje (Libosvárský, l.c.)	43	44	64	87	105	121					
Hlohovecký rybník, pond (Libosvárský, l.c.)	25	46	76	99	127	140					
Jarohněvický pond (Libosvárský, l.c.)	14	54	85	118	152	174	192	221			
Požár pond, (Klonfarová, 1978)	231	51	79	115	145	164	181	194			

On July 6th, 1985, the growth analysis was performed in 55 specimens. The sample included the Ist—IIIrd age groups, length groups were within the range of 51—57 mm. The values of the back-calculated body length for the first year reached 41 mm; for the second year 48 mm and for the third year 57 mm.

On July 25th, 1985, the catch from the natural pond Malá Arazimova included the Ist and the IInd age groups (48 specimens). The length groups were within the range of 49—55 mm. The crucian carp reached 42 mm at the end of the first year (back-calculated body length) and 53 mm at the end of the second year.

On September 28th, 1985, the material of the crucian carp included 65 specimens which belonged into the 0+ — IInd age class. The most frequent age class with 61 specimens was the first age class. The maximum body length of 52 mm was found in a specimen from the IInd age class, the smallest body length, 39 mm, in a specimen from the 0^- age class. The back-calculated length was 40 mm at the end of the first year, and 48 mm of the second year of life.

The crucian carp material from October 3rd, 1985, included 31 specimens, which belonged to 2 age groups. The most frequent was the first age class. The maximum body length of 52 mm was found in a specimen of IInd age class, the smallest body length of 46 mm in a crucian carp of the first age class. The back-calculated body length was 39, and 47 mm at the end of the first and the second year of life, respectively.

In the year 1986 three catches were performed. From the sample gained on May 14th, 26 specimens were studied, included the I—IIIrd age groups. The body lengths at the time of the capture were within the range of 25 mm (age class I) and 55 mm (age class III). The values of the back-calculated body length for the first year reached 38 mm, for the second year 44 mm.

On May 23rd, 1986 the growth analysis was performed in 37 specimens included in the Ist—IIIrd age groups. The length groups were within the range of 36—55 mm. The back-calculated length was 40 mm at the end of the first year, and 48 mm at the end of the second year.

On June 9th, 1986, the catch included the I—IIIrd age groups (54 specimens). The length groups were within the range of 30—58 mm. The back-calculated lengths were 40 and 46 mm at the end of the first, and second year of life, respectively.

In 1987, 51 specimens of three age classes were studied. The smallest specimen from the first age class measured 50 mm, the largest (80 mm) was enlisted into the third age class. The back-calculated body length was 37 mm (for the first), 48 (for the second) and 62 (for the third year of life).

In the pond Kroučová we caught 99 specimens with the length between 85 and 145 mm. The crucian carps belonged into the I—IIIrd age classes. The most frequent age class with 56 specimens was the third age class. Results of the length growth are summarized in Table 1.

From the pond Jan in Jevany we examined 21 specimens with body lengths in the range of 70—165 mm. The smallest specimen belonged to the IIIrd class, the largest to the VIth age class. The results of the length growth from back-calculated values are presented in Table I.

In the pond Vykáň 7 specimens of crucian carp with the body length in the range of 125—150 mm were studied. These crucian carps belonged to the IIIrd and IVth age classes. Results of the length growth are presented in Table 1.

From the Věstonice reservoir, 69 specimens were studied. The body lengths were in the range of 150—250 mm. The specimens belonged to the Vth—Xth age classes. The back-calculated body lengths are presented in Table 1.

Table 3. Comparison of the length growth of the crucian carp from foreign localities

Locality	n	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9
Neman river (Žukov, 1965)	7	19	43	64	89	111	135	152	174	191
Dnieper river (Kostjučenko, cit. Žukov, 1965)	32	19	45	64	78	99				
Siver lake, Latvian SSR (Sloka, 1959)	2	22	46	76	107	140	161	180	190	202
Dridzas lake, Latv. SSR (Sloka, 1959)	10	22	46	71	92	114	132	148	167	182
Reznas lake, Latv. SSR (Sloka, 1960)	21	21	46	97	112	140	150	175		
Mszar lake by Wegorzewo, 1956, Poland, (Zawisza and Antosiak, 1961)	29	25	38	69	94					
Čajki lake, river-basin of Donec, USSR, (Borg, 1949)	266	30	54	76	96	116				
Oświn lake by Wegorzewo, 1954, Poland (Zawisza and Antosiak, 1961)	37	32	62	90	117	143	182			
Bunbinek lake, 1953, by Wegorzewo, Poland (Zawisza and Antosiak, 1961)	14	33	60	85	120	157	192			
Arklickie lake, 1954, by Wegorzewo, Poland (Zawisza and Antosiak, 1961)	39	33	62	89	119	157	181	217		
River-basin of Dnieper (Žukov, 1965)	29	33	67	99	124	154	172			
Przerwanki lake, 1954, by Wegorzewo, Poland (Zawisza and Antosiak, 1961)	30	35	76	117	150	193	217			
Arklickie lake, 1955, Poland (Zawisza and Antosiak, 1961)	10	35	111							
Drissa river, USSR (Penjaz, cit. Žukov, 1965)	11	36	72	102	132	164	188	205	210	
Przerwanki lake, 1953, Poland (Zawisza and Antosiak, 1961)	33	36	78	121	153	199	226			
Borovoje lake, USSR (Borg, 1949)	261	37	66	97	129	144				

Table 4 The weight growth of the crucian carp in various localities (in grams)

Locality	w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	w_9	w_{10}
Mala Arazimova natural pond 1984	2 5	4 9								
Mala Arazimova natural pond 1985	1 6	3 2	4 0							
Mala Arazimova natural pond 1986	1 5	2 5								
Mala Arazimova natural pond 1987	1 4	3 1	6 4							
Kroucova pond	3 5	12 5	28 5	45						
Jan pond Jevany	1 8	6 9	22 9	52	72					
Vykan pond	2 4	7 5	20	45	66					
Věstonice riverine lake	5 1	18 8	49	93	146	204	260	325	384	465
Jasien by Gdansk, Poland	0 8	2 4	6 3	19						
Gorki Wschodnie by Gdansk Poland	0 7	2 4	4 7	11	20					
Karczemki Kielpinskie, by Gdansk Poland	1 4	2 8								
Drissa river USSR, (Žukov 1965)	2 2	17	49	108	206	310	402	430		
Neman river, USSR, (Žukov 1965)	0 3	3 2	10	28	58	95	140	208	276	
Dnieper river USSR, (Žukov, 1965)	1 5	12 6	30	84	163	228				

In the Polish natural pond Jasień near Gdańsk 29 specimens were caught in the range of 45—125 mm of the body length These crucian carps belonged into the IInd—IVth age classes Results of the length growth are summarized in Table 1

From the locality Gorki Wschodnie in Poland we examined 10 specimens with body lengths between 50 and 90 mm The crucian carps belonged to the IInd—Vth age classes The results of the length growth are presented in Table 1

From the natural ponds of the locality Karczemki Kielpinskie in the vicinity of Gdańsk in Poland we had to our disposal 14 specimens with their body lengths between 35 and 55 mm (the I and IInd age classes) The results are given in Table 1

When we compare the growth rate of crucian carps from the studied localities according to the size of the increment in the first year of life, the growth rate is the slowest in the Polish natural ponds Gorki Wschodnie as to the Czech localities, in the pond Jan in Jevany and in the pond Vykaň A very fast growth rate in the first year of life (53 mm) was found in the pond Kroucova

In 1978 a very fast growth rate in the Mala Arazimova natural pond in the second and third years of life is registered On the other hand in 1985 the growth rate in the natural pond Mala Arazimova appears to be the slowest In 1978, the number of crucian carps decreased In 1985 using the method of the amount estimation of Schnabel (Oliva 1959 1960a b) the crucian carp population was estimated to be 153 500 fishes per hectare and the average biomass was 568 kg per hectare The growth rate is smaller owing to the well known fact that a large number of fishes here get into a strong food competition (Khalid 1986)

The comparison of the growth of the crucian carp in Czechoslovak localities and localities abroad is shown in Table 2 and Table 3

Remarkable is the very slow growth rate in the river West Dvina, in the river Neman and Dnieper (Žukov 1965), in the Latvian lakes Siver and Dridzas (Sloka, 1959) in lake Reznas (Sloka 1960) in the first year of life. The length growth found in the Jarohnevicky pond and Požar pond was fast in the first year of life.

Remarkably very old fishes, with extremelly slow length growth were studied by Čihař (1957). In the natural pond Karasi tuň by Čelakovice (the so called crucian carp natural pond) the cited author observed 10 years old fishes with minimal length increments.

Žukov (1965) studied 9 years old fishes (in the river-basin of Neman) and found a faster length growth. The present authors found a fast length growth in very old fishes in the Vestonice riverine lake.

The weight growth

The weight of the crucian carp inhabiting the Mala Arazimova natural pond was determined in 121 specimens in 1984. The heaviest specimen (12 g) measured 75 mm the smallest weight (2 g) was found in the crucian carp of 40 mm. The weight growth was calculated according to the following equation

$$\log W = -4.36336 + 2.87802 \log SL ,$$

correlation coefficient $r = 0.99123$. The back calculated weight is expressed in Table 4.

In 1985, the weights of specimens were calculated on the basis of the nine catches performed during the year. The minimum weight was found in a crucian carp of 35 mm in lenfith, 0.6 gram. The maximum weight was found in a specimen of 90 mm standard length 10.6 grams. The length weight relation was calculated as

$$\log W = -4.68054 + 3.00685 \log SL , \qquad r = 0.99808$$

The results of the weight growth calculated are summarized in Table 4.

In 1986, the specimens of both catches were weighed. The minimum weight (0.7 g) was found in the specimen of 30 mm standard length. The maximum weight (15 g) was found in a crucian carp of 75 mm SL. The length weight relationship calculated has the following formula $\log W = -4.79166 + 3.11688 \log SL$.
The high value of the correlation coefficient reveals the proximity of the dependence ($r = 0.98749$). The back calculated weights are demonstrated in Table 4.

In 1987, the smallest specimen in age group I had the weight of 3.5 g and measured 50 mm. The largest weight was 14.5 g in a specimen of 65 mm standard length from the 3rd age class. The weight growth was calculated according to the following equation

$\log W = -4.37317 + 2.88952 \log SL$ correlation coefficient $r = 0.98022$. The results of the weight growth are expressed in Table 4.

From the results of the study of the weight growth (from Mala Arazimova natural pond) which of course is dependent on the length growth it is evident that the growth rate in the first year of life is decreasing from 1984 to 1987 year by year. The slow growth of the crucian carp shows that this natural pond was overpopulated.

In the Kroučova pond the largest weight was 110 g in a specimen of 145 mm of the length. The smallest weight (17 g) was found in a specimen of 85 mm long. The weight growth was calculated according to the following equation

$\log W = -5.36116 + 3.42298 \log SL$ correlation coefficient $r = 0.99851$. The weight growth is presented in Table 4.

The weight of the crucian carp inhabiting the Jan pond in Jevany was determined by the equation: $\log W = -4.024339 + 2.76891 \log SL$. $r = 0.98962$. The heaviest specimen (128 g) measured 155 mm, the smallest weight (14 g) was found in the crucian carp of 80 mm. The weight growth is summarized in Table 4.

In the pond Vykáň, the minimum weight (64 g) was found in a specimen of *125 mm in length. The maximum weight was found in a crucian carp of 150 mm* SL 104 g. The length-weight relation was calculated as: $\log W = 3.65057 + 2.61215 \log SL$, with the value of the correlation coefficient $r = 0.97281$. The results of the weight growth are presented in Table 4.

In the Věstonice riverine lake, the minimum weight found was 160 g (150 mm SL), the maximum weight, 280 g, in a crucian carp of 250 mm. The following length-weight relation was calculated $\log W = -3.68357 + 2.68715 \log SL$. $r = 0.97192$

In the Jasień natural pond in Poland, the smallest weight (2.4 g) was found in a specimen of 45 mm of length, the largest weight was 62 g in a specimen of 125 mm The weight growth was calculated according to the following equation:
$\log W = -4.95351 + 3.22346 \log SL$, correlation coefficient $r = 0.99474$. The results of the weight growth are expressed in Table 4.

From the locality Górki Wschodnie in Poland, the smallest specimen had the weight of 4 g and measured 50 mm. The largest weight was 20.7 g in a specimen with 90 mm of standard length. The length-weight relationship calculated has the following formula:
$\log W = -4.95168 + 3.26231 \log SL$, correlation coefficient $r = 0.93549$. The results of the weight growth are presented in Table 4.

From the natural ponds of the locality Karczemki Kielpinskie in the vicinity of Gdańsk in Poland, the minimum weight (1.5 g) was found in a specimen of 35 mm of standard length, the maximum weight 4.0 g in a crucian carp of 55 mm SL. The weight growth was calculated according to the following equation:

$\log W = -3.15729 + 2.16800 \log SL$. $r = 0.99164$.

The back-calculated weights are demonstrated in Table 4.

When we evaluate the weight growth of the crucian carp from the water bodies studied, we see that our specimens reach maximum increments in the Věstonice riverine lake, followed by the Kroučová pond and the Malá Arazimova natural pond (1984). The smallest increments in the first year of the life were found in the river Neman in Soviet Union (Žukov, 1965) and Górki Wschodnie natural pond and Jasień natural peat bog (in Poland). The weight growth could be compared only with in data from abroad because those from the Czechoslovak localities are still lacking.

Hnízdo (1968) cited the maximum weight of the crucian carp, 1500 g, caught in Jordán pond in Tábor (in 1913); the age was not stated. A high value of the weight growth of the crucian carp from the lower part of the river Sázava (1100 g in 1967) is reported by Hanel (1983). This author also published the survey of the maximum length growth of the crucian carp in Czechoslovakia and in the area of its distribution.

The growth indexes and growth equations

The growth rate and the size of the upgrowth of the length increments were also evaluated by means of the index of the population growth rate and the population growth intensity. The values of the index of population linear growth intensity (φC_l) in the 1st to the 3rd year document the increment of the length of the body

Table 5. Comparison of the length growth of the crucian carp from Czechoslovak and foreign localities based on the growth parameter R_p

Locality	R_p 1 – 3	Rp 1 – 5
Lubná pool (Oliva and Hruška, 1955)	85.32	—
Svätuša pool 1956 (Libosvárský, 1960/1; 1963)	89.02	—
Neman river (Žukov, 1965) USSR	90.46	268.33
Dnieper river (Žukov, 1965), USSR	92.73	254.68
Karasí tůň, natural pond (Čihař, 1957)	101.06	217.20
Mszar lake 1956 (Zawisza and Antosiak, 1961) Poland	101.54	—
Dridzas lake (Sloka, 1959) Latvian SSR	102.73	286.22
Bačka pool 1958 (Libosvárský, 1960/1; 1963)	105.72	—
Pavlovo branch of Bodrog river (Libosvárský, 1960/1; 1963)	105.97	250.21
Siver lake (Sloka, 1959) Latvian SSR	106.04	318.72
Górki Wschodnie, Poland (present authors)	106.92	244.97
Reznas lake (Sloka, 1960), Latvian SSR	114.68	338.31
Jasień, Poland (present authors)	117.53	—
Černá tůň, natural pond, (Oliva and Hruška, 1955)	124.14	—
Čajki lake, USSR (Berg, 1949), river-basin of Donec	124.43	317.20
Bačka pool 1956 (Libosvárský, 1969/1; 1963)	126.58	—
Malá Arazimova natural pond 1987 (present authors)	129.50	—
Malá Arazimova 1985 (present authors)	133.12	—
Lelos pool (Libosvárský, 1960/1; 1963)	136.05	326.56
Vykáň pond (present authors)	136.85	340.17
Bimbinek Lake 1954 (Zawisza and Antosiak, 1961)	137.94	380.73
Oświn lake (Zawisza and Antosiak, 1961) Poland	139.45	373.58
River-basin of Dnieper (Žukov, 1965)	139.85	393.16
Arktickie lake 1954 (Zawisza and Antosiak, 1961)	140.94	385.90
Jan pond by Jevany (present authors)	143.74	365.03
Přítlucká jezera (Libosvárský, 1960/1; 1963), pool	150.53	—
Borovoje lake, USSR (Berg, 1949)	155.95	400.09
Drissa river (Peňáz, cit. Žukov, 1965) USSR	157.06	425.91
Zaječské jezero, pool (Libosvárský, 1960/1; 1963)	164.10	370.74
Przerwanki lake (Zawisza and Antosiak, 1961) 1954	164.59	473.33
Věstonice riverine lake (present authors)	171.64	420.95
Przerwanki lake 1953 (Zawisza and Antosiak, 1961)	171.74	486.83
Hlohovecký pond (Libosvarský, 1960/1; 1963)	176.97	423.48
Kroučová pond (present authors)	192.59	—
Malá Arazimova 1978 (present authors)	197.86	—
Požár pond (Klonfarová, 1978)	200.32	478.21
Jarohněvický pond (Libosvárský, 1960/1; 1963)	209.95	503.96

In the Malá Arazimova natural pond the largest value is given for 1978 $\varphi C_l =$ $= 66.31$; for 1985 it is 16.87. The smallest value of $\varphi C_l = 33.30$ was found in the Polish locality Górki Wschodnie.

From the values of the index of the population growth rate it is evident that the largest growth rate was in Malá Arazimova natural pond in 1978 ($\varphi C_{lh} = 30.38$); the slowest growth, according to the index $\varphi C_{lh} = 6.81$, in Malá Arazimova natural pond in 1985. A relatively fast growth was also found in the riverine lake Věstonice ($\varphi C_{lh} = 22.96$). The slow growth according to the index $\varphi C_{lh} = 9.90$ was found in the locality of Górki Wschodnie. The application of the indexes mentioned seems not very suitable, because it does not cover satisfactorily the changes in the growth rate in the individual years of life

The growth rate is evaluated satisfactorily by the growth parameter Rp. The length growth characterized by the given index is expressed in Table 5, representing firstly the period of the 1st to 3rd year of life secondly the period of the 1st to 5th year of life

The largest value is given for Mala Arazimova (in 1978), Kroučova pond and *Vestonice riverine lake* *the smallest* Rp = *106.9* for Gorki Wschodnie natural pond The medium growth rate was found in the Vykaň and Jan ponds

When we compare the length growth of the crucian carp by the growth parameter Rp from other localities (Table 5) we can see that the growth in the Lubna natural pond (Oliva and Hruska 1955) in the locality of Svatuša in 1956 (Libosvarsky 1963) in the Dniepr and Neman rivers (Žukov 1965) is the slowest out of all localities cited A very fast growth rate was found in the Kroučova pond in the Mala Arazimova natural pond (in 1978) and in the Pozar and Jarohnevicky ponds

From the values cited of the growth parameter (Table 5) it is evident that it is possible to distinguish the rate of growth also within two localities growing similarly very rapidly as e g Pozar and Jarohněvicky ponds for the period of 0—3 years of life and similarly it is possible to differentiate significantly among localities as e g Przerwanki lake Pozar and Jarohněvický ponds for the period of 0—5 years of life

The back calculated body lengths were used for the construction of the length growth equation according to Bertalanffy (Ricker 1975) The Ford Walford's method was used According to our data individual parameters of the growth equation were calculated as follows

$$l_t \quad L_\infty(1 - e^{-K(t\ t_0)})$$

Representing the exponential growth by the parameters obtained we got the following curve of numerical equations

Mala Arazimova 1978 $l_t = 255\,(1 - e^{0.2262\,(t-0.136\text{[illegible]})})$
Mala Arazimova 1985 $l_t = 59\,(1 - e^{1.0116\,(t+0.2184)})$
Mala Arazimova 1987 $l_t = -3.33\,(1 - e^{+0.2412\,(t\ 9.3383)})$
Kroucova pond $l_t = 166\,(1 - e^{-0.2473\,(t+0.5463)})$
Jan pond (Jevany) $l_t = 420\,(1 - e^{0.0771\,(t-0.0554)})$
Vykan pond $l_t = 5867\,(1 - e^{0.0039\,(t\ 0.4263)})$
Vestonice riverine lake $l_t = 361\,(1 - e^{-0.0992\,(t+0.3025)})$
Jasień natural peat bog $l_t \quad -24\,(1 - e^{0.2076\,(t+3.0428)})$
Gorki Wschodnie natural ponds $l_t = -151\,(1 - e^{0.0626\,(t+1.9118)})$

The comparison of the values back calculated from scales and those obtained according to the Bertalanffy's model shows deviations of 1—4 mm in different age groups

CONCLUSIONS

In 1978 and 1984—1987 the length and weight growth of the *crucian carp* (*Carassius carassius*) in Mala Arazimova natural pond was studied using the scale methods in 892 specimens In 1978 a very rapid growth was found In 1985—87, the growth rate was slower due to overfishing and food competition

In the Kroucova pond and in the Vestonice riverine lake a fast length growth was found The growth rate in two Polish localities appears to be the slowest (Gorki Wschodnie natural pond and Jasień natural peat bog)

The length weight relationships for the back calculation of the weight were stated In the Mala Arazimova natural pond the weight growth rate is decreasing from 1984 to 1987 year by year A faster weight growth can be noticed in the Věstonice riverine lake A small weight growth is given from two Polish natural ponds from Gorki Wschodnie and Jasień

The growth rate was also evaluated by means of the index of the population growth rate and the population intensity The length growth rate is evaluated more satisfactory by means of the growth parameter Rp When we compare the growth rate in the localities studied with the data of the growth parameters from abroad the growth in the Mala Arazimova natural pond (in 1985—87) appears to be slow The data from the natural ponds Gorki Wschodnie and Jasien are always lower A faster growth is evident in the Věstonice riverine lake the Kroučova pond and in the Mala Arazimova natural pond (in 1978)

The exponential character of the length growth ascertained according to the body length growth was expressed by Bertalanffy's growth equations The values back calculated from the scales and those obtained according to Bertalanffy's model show deviation of 1—4 mm in different years

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SOME NEMATODE PARASITES FROM AMPHIBIANS AND REPTILES FROM ZAMBIA AND UGANDA

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Abstract. An examination of small samples of several species of amphibians (*Bufo regularis*) and reptiles (*Chamaeleo dilepis*, *Hemidactylus mobouia*, *Agama cyanogaster* and *Bitis arietans*) from Zambia and from Uganda (*Ptychadena mascareniensis*) yielded altogether 6 species of nematodes, one of them being new to science. These include *Cosmocerca ornata japonica*, *Aplectana macintoshii*, *Skrjabinodon hemidactyli* sp. n., *Orneoascaris chrysanthemoides*, *Hexametra quadricornis*, and *Pseudabbreviata amaniensis*. *S. hemidactyli* sp. n. differs from all other congeners mainly in the length of spicule (0.060 mm), relative length of the female tail to the body length (1 : 3), number of caudal spines (4) in females, and in some other features. *Cosmocerca ornata* (Dujardin, 1845) sensu Baker et Vaucher, 1984 from South American frogs is considered an independent new species for which the name *C. uruguayensis* sp. n. is now proposed. The species *Abbreviata benoiti* Horchner et Weissenburg, 1965 and *A. cyanogasteri* Horchner et Weissenburg, 1965 are considered synonymous with *Pseudabbreviata amaniensis* (Sandground, 1928). *Parathelandros canariensis* and *Parapharyngodon aegyptiacus* are transferred to *Skrjabinodon* Inglis, 1968 as *S. canariensis* (Solera-Puertas, Zapatero-Ramos, Cstaño-Fernandez et Carrera-Moro, 1987) comb. n. and *S. aegyptiacus* (Moravec, Baruš et Ryšavý, 1987) comb. n. All the six reported species represent the first records from Zambia and Uganda and *C. ornata japonica* is for the first time reported from Africa. *P. amaniensis* in *Agama cyanogaster* represents a new host record.

Until now few studies have been made on the helminth parasites of African amphibians and reptiles and despite the great interest of herpetologists and other zoologists, the helminth fauna of these cold-blooded vertebrates remains poorly known (see Simbotwe 1979).

During several recent years, while examining a few amphibian and reptilian specimens representing occasional findings from Zambia and Uganda, we collected some parasitic nematodes the systematic evaluation of which is the subject of this paper.

MATERIALS AND METHODS

Most nematode specimens were collected from fixed host amphibians and reptiles. These originated from Zambia and Uganda and were identified by Dr. R. B. Zweifel from the American Museum of Natural History in New York.

Zambia: — A total of 9 frog and toad specimens and 10 lizard specimens belonging to several species were examined, of them, only the following species harboured the nematodes: Amphibia — *Bufo regularis* Reuss (2 specimens), Reptilia — *Chamaeleo dilepis* Leach (2 specimens), *Hemidactylus mabouia* (Jonnés) (1 specimen), and *Agama cyanogaster* (Ruppel) (2 specimens). All these were collected by the Czechoslovak veterinarian Dr. A. Buš in the Copperbelt region in the surroundings of the towns of Ndola and Mufulira in the spring of 1976.

Uganda: — Only 1 specimen of the frog *Ptychadena mascareniensis* (Dumeril et Bibron) was examined; it was collected by the Czechoslovak parasitologist Dr. F. Dusbábek in Toro Game Reserve on 27 January 1978.

In addition to these materials, a sample of ascaridoid nematodes (*Hexametra quadricornis*) was provided by the herpetologist Mr M. Kaftan from Prague; the nematodes were collected from the African viper *Bitis arietans* Wagl. which had died shortly after its import from Zambia to Czechoslovakia in the autumn of 1986.

For examination the nematodes were cleared with glycerine. All drawings were made with the aid of a camera lucida. All materials are deposited in the helminthological collection of the Institute of Parasitology, Czechoslovak Academy of Sciences, in České Budějovice. In the following account of the species encountered, measurements are given in millimetres.

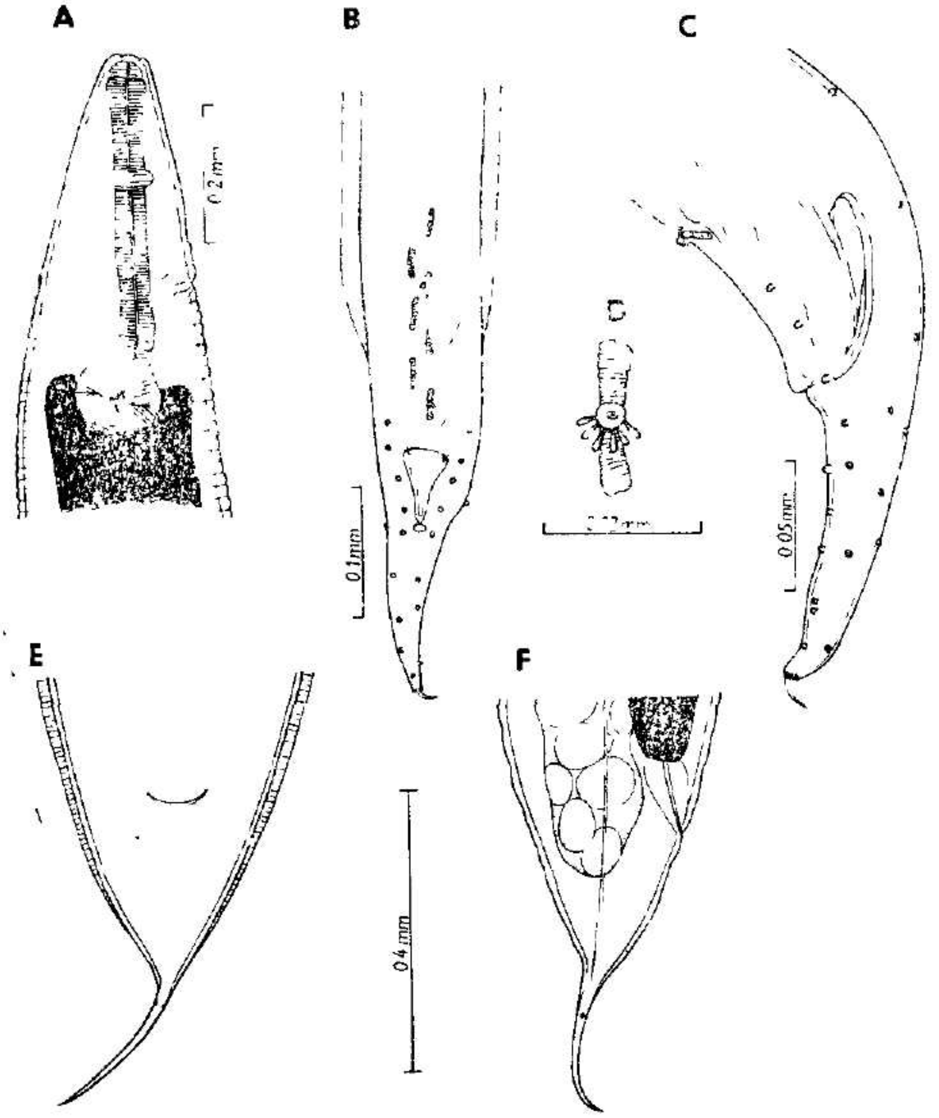

Fig. 1 *Cosmocerca ornata japonica* Yamaguti, 1938 from *Bufo regularis*. A – head end of female; B – posterior end of male; ventral view; C – tail of male, lateral view; D – plectane; E, F – tail of female, ventral and lateral views.

REVIEW OF SPECIES

Fam. Cosmocercidae Railliet, 1916

1. *Cosmocerca ornata japonica* Yamaguti, 1938 (Fig. 1)

Syn.: *Cosmocerca japonica* Yamaguti, 1938; *Paracosmocerca mucronata* Kung et Wu, 1945; *Cosmocerca ornata* (Dujardin, 1845) sensu Moravec, Baruš et Ryšavý, 1987.

Host: *Bufo regularis* Reuss (fam. Bufonidae).
Localization: intestine.
Locality: Copperbelt region, Zambia (spring 1976).
Prevalence: in 1 out of 2 *B. regularis* examined (intensity 19 specimens).

Description: Small, whitish nematodes of fusiform body. Oesophagus anteriorly with short pharynx, posteriorly with bulb provided with valvular apparatus. Narrow lateral alae extending from head end nearly to mid-length of tail in female and to second pair (counting from cloacal opening) of plectanes in male. Excretory pore anterior to bulb level.

Male (1 specimen): Length of body 1.20, maximum width 0.102. Numerous somatic papillae present. Width of lateral alae 0.009. Length of entire oesophagus 0.312; length of pharynx 0.021, length of bulb 0.048, its width 0.051. Nerve ring and excretory pore 0.135 and 0.216, respectively, from anterior extremity. Well sclerotized, 0.096 long gubernaculum present; spicules rudimentary, weakly sclerotized. Four plectanes present on left side and three on right side of body, rosette papillae of plectanes provided with 6—9 minute, posteriorly directed processes. Oblique, paired subventral muscle bands present in region of plectanes. Tail provided with some 32 postantal papillae distributed ventrally, subventrally, laterally and subdorsaly; genital papillae indistinguishable from somatic papillae; one pair of subventral papillae situated in proximal third of tail markedly larger than somatic papillae. Tail conical, 0.153 long, with terminal spike 0.021 long.

Female (10 specimens). Body length of gravid females 2.20—3.85, maximum width 0.258—0.422. Width of lareral alae 0.016—0.024. Length of entire oesophagus 0.405—0.625; length of pharynx 0.021—0.030, that of bulb 0.096—0.126, its width 0.105—0.186. Nerve ring and excretory pore 0.216—0.219 and 0.186—0.381, respectively, from anterior extremity. Uterus prodelphic. Vulva situated near midbody, at 1.13—1.88 from anterior end. Eggs oval, thin-walled, containing larvae; size of mature eggs 0.129—0.150 × 0.081—0.102. Tail conical, 0.360—0.528 long (representing 14—16% of body length), ending in long, slender caudal spike, length of spike-like portion of tail 0.225—0.270, representing 51—63% of whole length of tail. Minute outlets of phasmids situated in posterior half of tail length.

Comments: — The species *Cosmocerca ornata* (Dujardin, 1845), a common parasite of anurans in Europe, was first reported from African continent by Baylis (1923) from "a frog" in Egypt. Later the same species was recorded from Sierra Leone (Puylaert 1970), South Africa (Baker 1981), Upper Volta (Baker and Vaucher 1984) and Egypt (Moravec et al. 1987a), and probably also the finds of *Cosmocerca* sp. from *Rana* (= *Ptychadena*) *mascareniensis* and *Bufo* spp. from the Sudan (Pike 1979) refer to this species.

According to Baker and Vaucher (1984), *C. ornata* occurs in several zoogeographical regions of the Old World (Europe, Africa, India, Malaysia, China) and these authors recorded it even from from three *Leptodactylus* species from South America (Paraguay). However, the description of these South American species given by Baker and Vaucher (1984) indicates that there are some distinct morphometrical differences between them and conspecific materials from Europe. It concerns mainly the shape and relative length of the female tail, size of the body of gravid females, and the extent and width of lateral alae. While the length of the female tail represents 15—18% of the whole body length and it is tapering abrumptly in proximal eighth to a long spike-like posterior portion in South American specimens, the female tail of European specimens represents only 5—9% of the body length and its spike-like portion is shorter that a half of the tail; lateral alae in South American females are narrow (0.018 mm), extending posteriorly only to the proximal thick part of the tail (i.e. to one eighth of tail length), whereas those in European females are broad (0.036—0.45 mm), extending posteriorly below the mid-length of tail (to third or fourth fifth of the tail length); the same concerns the position of phasmids. While the length of gravid females of the South American material is only 2.6—4.0 mm, the gravid females of *C. ornata* from Europe measure 4.4—10.3 mm (see e.g. Travassos 1931, Moravec and Vojtková 1974, Hartwich 1975, Ryzhikov et al. 1980). Because of these facts, we cannot agree with Baker and Vaucher (1984) that the above mentioned South American specimens belong to *C. ornata* (Dujardin, 1845). In our opinion they represent a new, hitherto undescribed species, for which the name *Cosmocerca uruguayensis* sp. n. is now proposed (this species is established by indication (see Art. 16 of the International Code of Zoological Nomenclature).

The morphology of the present specimens is practically identical with that of the specimens collected from *Bufo regularis* and *Rana* spp. from Egypt and reported by Moravec et al. (1987a) as *C. ornata*. But in comparison with the conspecific materials from European frogs and toads, these African nematodes are substantially smaller (body length of gravid females only 2.2—5.6 mm compared to 4.4—10.3 mm in European *C. ornata*) and there are also some other slight morphometrical differences between them (width of lateral alae in females 0.016—0.024 mm versus 0.036—0.045 mm, phasmids on female tail small, situated approximately in mid-length of tail compared to conspicuous, spike-like phasmids shifted more posteriorly in European *C. ornata*). By these features the African specimens are indistinguishable from the Asian species *C. japonica* Yamaguti, 1938, which is considered as only a possible subspecies of *C. ornata* by Moravec and Sey (1985); *C. japonica* has been reported to occur in Japan, China, Vietnam and Oceanica.

In our opinion, it seems reasonable to consider the nematodes designated as *Cosmocerca japonica* Yamaguti, 1938 as well as those of the present material and those reported as *C. ornata* by Moravec et al. (1987a) from Egypt as a separate subspecies *Cosmocerca ornata japonica* Yamaguti, 1938 in contrast to the nominate subspecies *C. ornata ornata* (Dujardin, 1845); it appears that while the second subspecies (*C. ornata ornata*) is distributed in the temperature zone of Europe, the first one (*C. ornata japonica*) parasitizes frogs and toads in the subtropical and tropical regions of Africa and Asia. Unfortunately, except for the paper by Moravec et al. (1987a), there are no descriptions of *C. ornata* in the literature relating to the materials from Africa and, consequently, it can be only supposed that they belonged to *C. ornata japonica* too.

2. *Aplectana macintoshii* (Stewart, 1914) (Fig. 2)

Syn.: ?*Oxyuris praeputialis* Skrjabin, 1916; *Aplectana schneideri* Travassos, 1931; *Oxysomatium punctatum* Walton, 1933; *O. brevispiculum* Yuen, 1965; *O. minutum* Rasheed, 1965

Hosts: *Bufo regularis* Reuss (fam. Bufonidae) and *Ptychadena mascareniensis* (Dumeril et Bibron) (fam. Ranidae).

Localization: intestine and cloaca.

Localities: Copperbelt region, Zambia (in *B. regularis* — spring 1976) and Toro Game Reserve, Uganda (in *P. mascareniensis* — 27 January 1978).

Occurrence: in 1 out of 2 *B. regularis* from Zambia (intensity 15 specimens) and in single *P. mascareniensis* from Uganda (1 specimen).

Description: Small, whitish nematodes of fusiform body. Lateral alae extending from anterior end of body to tail. Oesophagus anteriorly with short pharynx, posteriorly with bulb provided with valvular apparatus. Excretory pore situated at level of anterior border of bulb.

Male (1 specimen from *B. regularis*; measurements of 1 specimen from *P. mascareniensis* in parentheses): Length of body 1.59 (1.95), maximum width 0.218 (0.218). Length of entire oesophagus 0.354 (0.330); length of pharynx 0.018 (0.024), that of bulb 0.084 (0.063), its width 0.090 (0.060). Nerve ring and excretory pore 0.106 (0.066) and — (0.324), respectively, from anterior extremity. Two well sclerotized spicules with sharply pointed distal ends present; length of spicules 0.233 (0.195). Gubernaculum moderately sclerotized, length some 0.060 (—). Genital papillae indistinguishable from somatic papillae. Anterior lip of cloaca bearing one unpaired papilla. Postnatal papillae approximately 24—32 in number, these being localized subventrally, laterally and subdorsally. Tail conical, 0.270 (0.245) long, ending in sharp cuticular point.

Female (10 specimens from *B. regularis*): Body length of gravid females 3.05—4.76, maximum width 0.326—0.530. Length of entire oesophagus 0.585—0.625; length

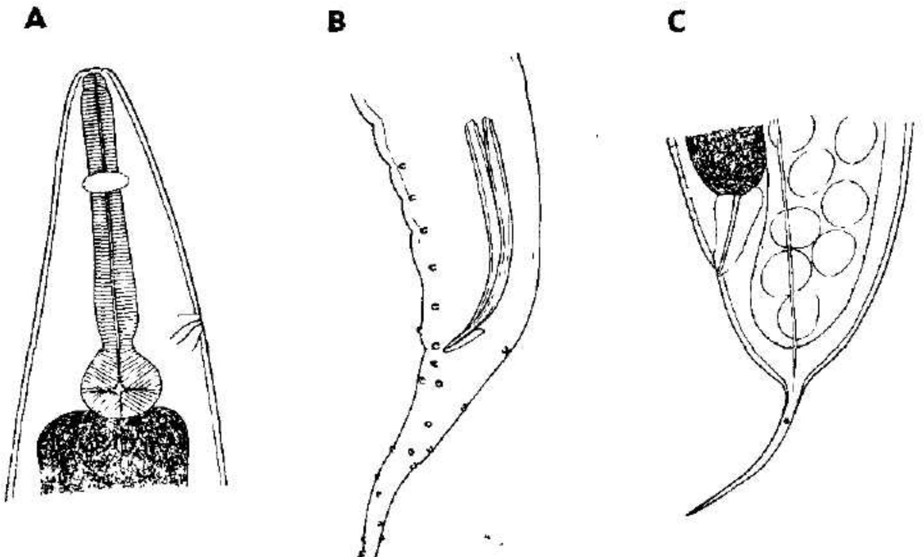

Fig. 2. *Aplectana macintoshii* (Stewart, 1914). A — head end of female; B — tail of male; C — tail of female.

of pharynx 0.021–0.024, that of bulb 0.117–0.135, its width 0.123–0.153. Nerve-ring and excretory pore 0.190–0.245 and 0.299–0.330, respectively, from anterior extremity. Uterus prodelphic. Vulva near middle of body, 1.40–2.41 from anterior end of body. Eggs oval, thin-walled, containing larvae; size of eggs 0.093–0.105 × 0.054–0.072. Tail conical, 0.476–0.544 long, ending in long, slender cuticular spike

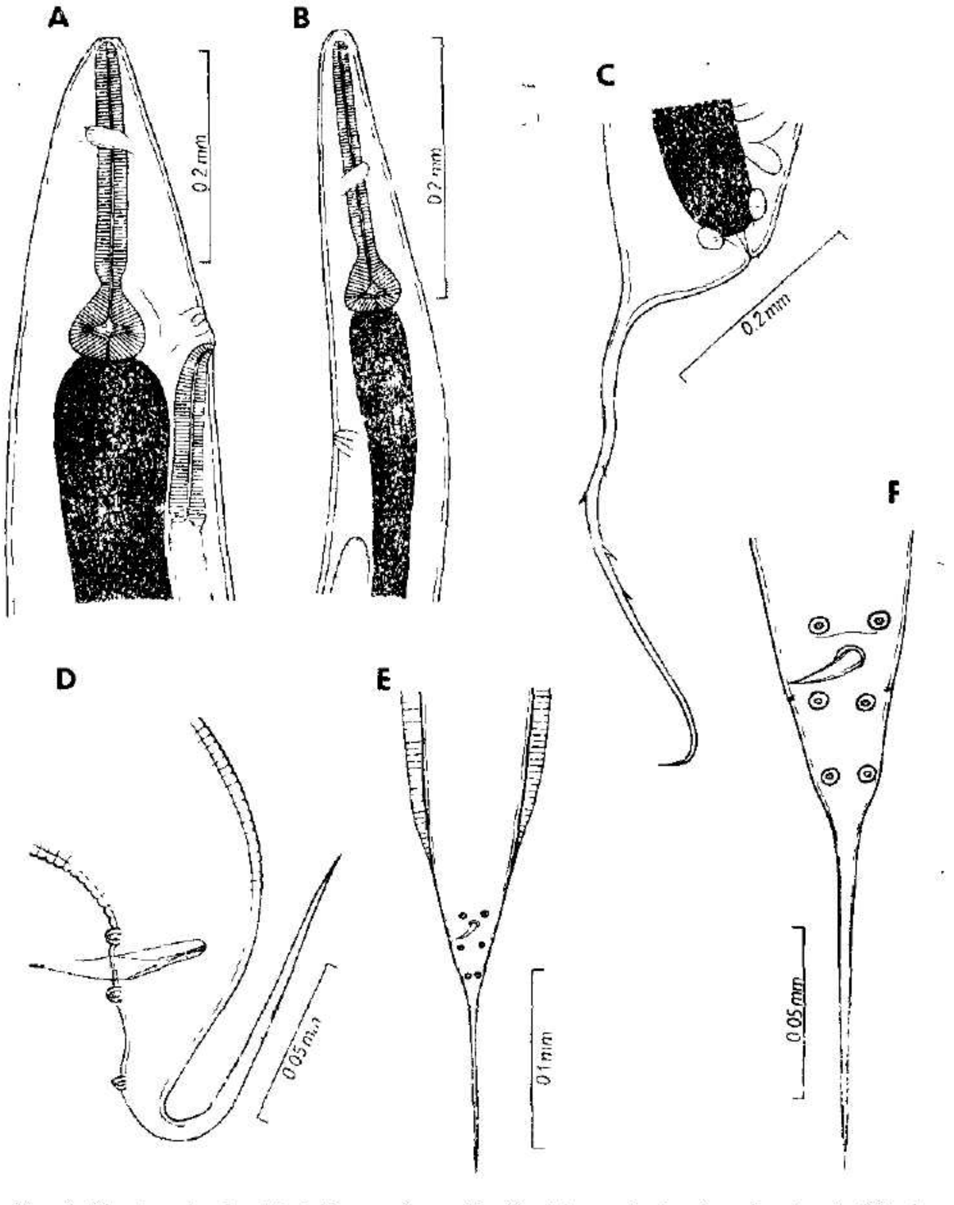

Fig. 3. *Skrjabinodon hemidactyli* sp. n. from ***Hemidactylus mabouia*. A** — **head** end of female; B — head end of male; C — tail of female; D — tail of male, **lateral view; E** — posterior end of male, ventral view; F — tail of male, ventral view.

(length 0.286—0.299). Pair of small papilla-like outlets of phasmids present in posterior half of tail.

Comments: — *A. macintoshii* is widely distributed in Africa, being reported from Egypt, Sudan, Morocco, Sahara, Senegal, Upper Volta, Congo, Tanzania and South Africa (see Baker 1980, 1981, Moravec et al. 1987a); it has not hitherto been reported from Uganda and Zambia. *B. regularis* and *P. mascareniensis* are the most frequently recorded hosts of *A. mascintoshii* in Africa.

Fam. Pharyngodonidae Travassos, 1919

3. *Skrjabinodon hemidactyli* sp. n. (Fig. 3)

Type host: ***Hemidactylus mabouia*** (Jonnés) (fam. **Gekkonidae**).
Localization: large intestine.
Type locality: Copperbelt region (surroundings of Ndola and Mufulira), Zambia (spring 1976).
Deposition of types: holotype, allotype and 5 paratypes in Institute of Parasitology, Czechoslovak Academy of Sciences, České Budějovice, Czechoslovakia, Helm. Coll. Cat. No. N — 459.
Etymology: The specific name of this species is derived from the generic name of its host.

Description: Small nematodes of fusiform body, cuticle transversely striated. Mouth surrounded by six small, round lips, each of them bearing one ill-visible papilla. Excretory pore situated at bulb level in females and in postoesophageal region in males. Tail ending in a long, slender caudal spike.

Male (1 specimen; holotype): Body narrow, 1.03 long and 0.109 wide, with transversely striated cuticle. Lateral alae well developed, 0.016 wide, extending along body, ending posteriorly a rather long distance in front of cloacal opening. Length of oesophagus including bulb 0.228, length of bulb 0.048, its width 0.048; bulb provided with sclerotized apparatus. Nerve ring and excretory pore situated 0.120 and 0.340, respectively, from anterior extremity. Testis reaching anteriorly somewhat below excretory pore level. Short, well sclerotized spicule with sharply pointed distal tip present, middle part of spicule markedly expanded; length of spicule 0.060, its maximum width 0.003. Three pairs of large sessile papillae present, of which first being preanal and remaining two postanal; pair of very small, ill-visible lateral papillae appearing to be present at level of first postanal pair, representing probably outlets of phasmids. Tail conical, its posterior part formed by a long, slender caudal spike; length of complete tail 0.150, of which caudal spike representing 0.105.

Female (6 specimens; measurements of allotype in parentheses): Length of body of nongravid females, including caudal spike, 1.02—1.81 (1.81), maximum width 0.122—0.231 (0.231); cuticle transversely striated. Length of whole oesophagus 0.326—0.340 (0.340), length of bulb 0.072—0.075 (0.075), its width 0.066—0.084 (0.084). Nerve ring and excretory pore 0.090—0.108 (0.108) and 0.204—0.313 (0.313), respectively, from anterior extremity. Width of lateral alae 0.006 (—). Vulva situated just below excretory pore, i.e. 0.231—0.340 (0.340) from anterior end of body. Anterior vulvar lip somewhat elevating. Vagina straight, pointing backwards, its anterior part forming distinct ovijector. Both ovaries situated in middle third of body length. Anterior, broad part of tail 0.039—0.082 (0.082) long, suddenly narrowing to form very long, slender caudal spike; latter 0.306—0.530

(0.530) long, its middle third provided with 4 (4) cuticular spines; spines not observed on smallest females.

Comments. — The general morphology of the present specimens shows their appurtenance to the genus *Skrjabinodon* Inglis, 1968 (see Inglis 1968, Petter and Quentin 1976, Roca 1985). According to Roca (1985) this genus includes a total of 8 species characterized by the presence of the spicule (besides those species in which it is absent): *S. parasmithy* Mawson, 1971, *S. mabuyae* (Sandground, 1936), *S. scelopori* (Caballero, 1938), *S. oedurae* (Johnston et Mawson, 1947), *S. capacyupanquii* (Teixeira de Freitas, Vicente et Ibañez, 1968), *S. circosaurae* Baruš et Coy Otero, 1974, *S. medinae* (Garcia Calvente, 1948), *S. schikhobalovi* (Annaev, 1973) and *S. mascomai* Roca, 1985. Moreover, also the species recently described as *Parathelandros canariensis* should be transferred to this genus as *Skrjabinodon canariensis* (Solera Puertas, Zapatero Ramos, Castaño Fernandez et Carrera Moro, 1987) comb. n.; in this paper the genus *Parathelandros* Baylis, 1930 is considered in accordance with the concept of Inglis (1968), Petter and Quentin (1976) and Moravec (1990) who list in it only the species parasitizing Australian and New Quinea frogs. In our opinion, also the species *Parapharyngodon aegyptiacus* should be transferred to *Skrjabinodon*; this species was established only on the available males and, accordingly, it was assingned to *Parapharyngodon* only tentatively. Its morphology is very similar to that of *S. canariensis* and both species might be even identical; consequently, we are transferring it to *Skrjabinodon* as *S. aegyptiacus* (Moravec, Baruš et Ryšavý, 1987) comb. n. Even though the males of *S. canariensis* and *S. aegpytiacus* seem to be morphologically indistinguishable and both the species were described from skinks of the genus *Chalcides* (see Solera Puertas et al. 1987, Moravec et al. 1987b), we think that, for the time being, until also females are described for the second species, it is reasonable to consider both species valid; the first species has been described from Canary Islands, while the second one from Egypt.

S. hemidactyli sp. n. distinctly differs from all the above mentioned congeneric species in the length of the spicule, except for *S. canariensis*, *S. aegyptiacus*, *S. mascomai*, *S. medinae*, *S. parasmithy* and *S. schikhobalovi*. However, in contrast to the new species, *S. canariensis* is characterized by a shorter female tail (0.40 mm versus up to 0.53 mm) and smaller relative length of the tail to the body length in females (1 : 8.8 compared to 1 : 3.0), larger body in females (2.9–4.1 mm versus 1.0–1.8 mm) and by the host types (Scincidae versus Gekkonidae); *S. mascomai* by the presence of a short, smooth female tail, greater body length in females (2.8–3.9 mm versus 1.0–1.8 mm) and by the geographical distribution (Spain versus Central Africa); *S. medinae* by the presence of a larger number of spines on the female tail (7–9 versus 4), length of the female body (4.5 mm versus 1.0–1.8 mm), host types (Lacertidae versus Gekkonidae) and goegraphical distribution (Spain versus Central Africa), *S. parasmithy*, in addition to some other features, by the significant difference concerning the chorology of both species (*S. parasmithy* being a species of the Flinders Islands — Australia) and *S. schikhobalovi* by the markedly elevated vulva, absence of caudal spines in females, host types (Lacertidae versus Gekkonidae), and by the geographical distribution (Soviet Central Asia versus Africa). *S. aegyptiacus*, for which females are unknown, can be separated from the new species by a relatively shorter spike-like portion of the male tail, host types (Scincidae versus Gekkonidae) and, perhaps, also by the geographical distribution (Northern (Egypt) versus Central (Zambia) Africa)).

Fam Ascaridae Baird 1853

4 *Orneoascaris chrysanthemoides* Skrjabin 1916 (Fig 4)

Syn *Ascaris involuta* Gedoelst 1916, *A bufonis* Gedoelst 1916 *A colubra* Baylis 1919, *Amplicaecum gedoelsti* Yorke et Maplestone 1926 *A africanum* Taylor, 1924, *A causi* Thwaite, 1926, *A novempapillatum* Sandground 1933 ? *A pesteri* Rasheed 1965

Hosts *Bufo regularis* Reuss (fam Bufonidae) and *Chamaeleo dilepis* Leach (fam Chamaeleontidae)
Localization stomach and anterior part of intestine
Locality Copperbelt region Zambia (spring 1976)
Occurrence in both *B regularis* examined (intensity 1 and 7 nematode specimens) and in both *Ch dilepis* (intensity 8 and 28 specimens)

Description Small ascaridoids males slightly smaller than females Lips almost square labial pulp deeply cleft into two rounded lobes denticles relatively large extending around whole border of lip Slender interlabia with membraneous edges present Lateral alae absent Oesophagus narrow long provided by three small terminal granular rounded lobes Ventriculus absent Nerve ring encircling oesophagus approximately at border of its first and second fourths Intestinal caecum on left side very long extending anteriorly almost to nerve ring level Excretory pore at level of nerve ring

Male (5 specimens from *Ch dilepis* measurements of 2 specimens from *B regularis* in parentheses) Length of body 18 28—30 41 (5 05) maximum width 0 585—0 966 (0 190—0 394) Lips 0 120—0 165 (0 057) long length of interlabia 0 045—0 060 (0 015) Length of oesophagus 2 63—4 67 (0 97), distance of nerve ring from anterior extremity 0 435—0 748 (0 285) of excretory pore 0 517—0 775 (—) Intestinal caecum 1 20—3 88 (0 61) long Posterior end of body of older males ventrally bent Spicules almost equal slender 1 15—2 18 (0 39—0 63) long Tail conical 0 258—0 340 (0 177—0 218) long with sharp conical mucron Caudal allae well developed extending approximately from anterior end of ejaculatory duct nearly up to end of tail Ventral precloacal surface in region of caudal alae provided with wrinkled ornamented area Thirteen (twelve to thirteen) preanal papillae present Additional unpaired papilla situated on anterior lip of cloacal opening Postanal papillae pair of subventral papillae present below cloacal opening and two pairs of smaller papillae near tail tip (in one specimen two papillae on one side and three papillae on opposite side) Phasmids lateral near last pair of subventral papillae

Female (5 specimens from *Ch dilepis* measurements of 5 nongravid specimens from *B regularis* in parentheses) Length of body 32 16—45 42 (5 05—17 61) maximum width 0 653—1 33 (0 245—0 707) Lips 0 150—0 195 (0 063—0 136) long, length of interlabia 0 060—0 075 (0 030—0 068) Length of oesophagus 1 97—3 67 (1 25—2 45) distance of nerve ring from anterior extremity 0 707—0 843 (0 299—0 344) of excretory pore 0 762—0 938 (0 299—0 317) Intestinal caecum 1 56—2 72 (0 98—1 97) long Vulva situated 13 46—18 20 (2 58—5 85) from head end Vagina directed posteriorly Eggs almost rounded 0 081—0 108 in diameter Tail conical with terminal mucron in small specimens in larger specimens becoming relatively shorter, often with withdrawn distal end length of tail 0 313—0 394 (0 122—0 135)

Comments — According to Sprent (1985) who revised this group of nematodes the genus *Orneoascaris* Skrjabin 1916 is a valid taxon the basic feature of which is the ornamentation of the male tail *O chrysanthemoides* was originally described from *Bufo* sp in East Africa but according to Sprent (1985) it is widely distributed

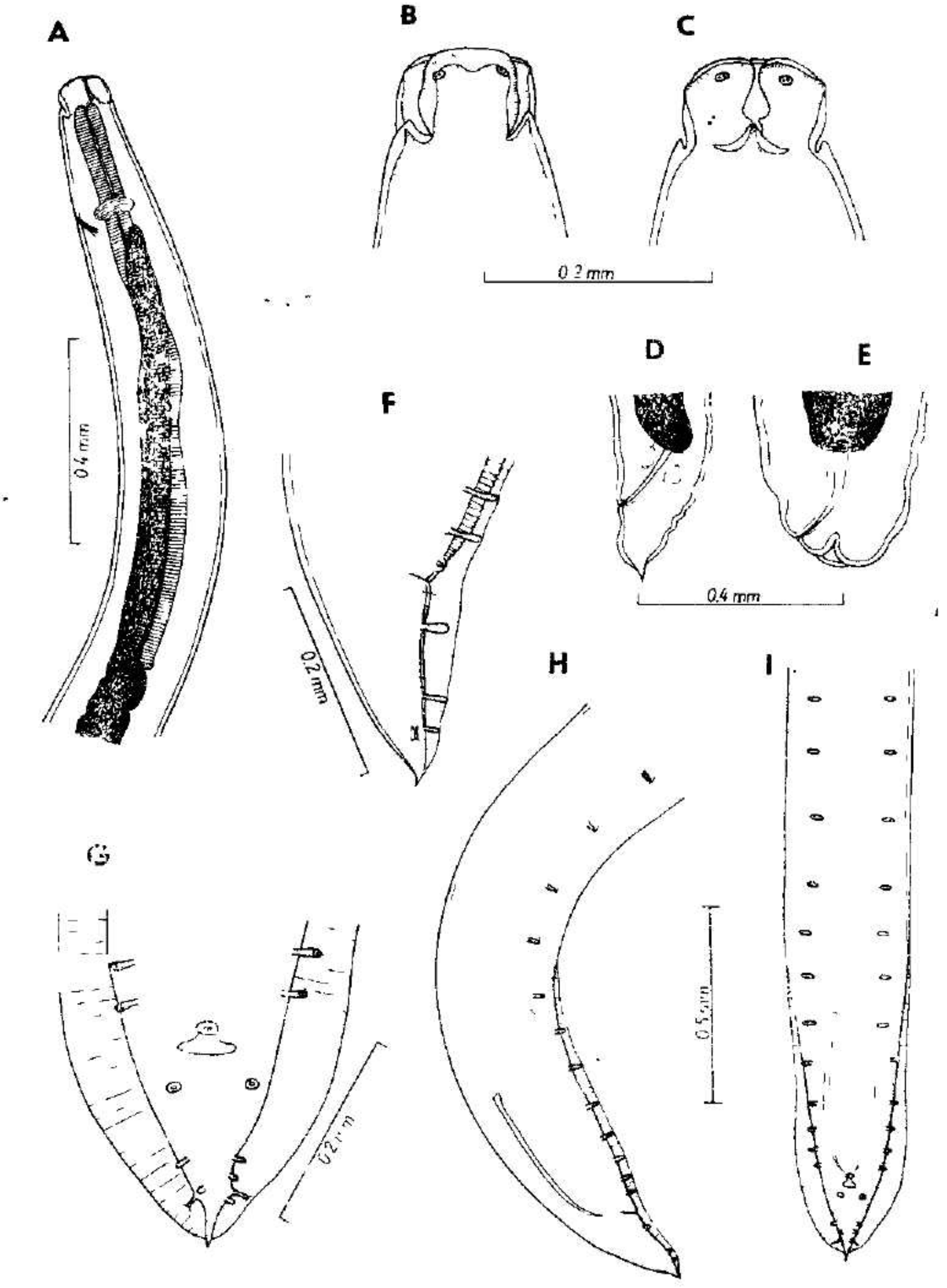

Fig. 4. *Orneoascaris chrysanthemoides* Skrjabin, 1916 A — anterior end of female body, B, C — head end, dorsal and ventral views, D — tail of juvenile female; E — tail of more advanced female; F, G — tail of male, lateral and ventral views; H, I — posterior end of male, lateral and ventral views.

in West and Central Africa, from where it was reported from various amphibian and reptilian hosts (toads, frogs, lizards, chelonians, snakes, crocodiles), including *Bufo regularis* and *Chamaeleo dilepis*. This species has not hitherto been reported from the territory of Zambia

5. *Hexametra quadricornis* (Wedl, 1861) (Fig. 5)

Syn.. *Ascaris quadricornis* Wedl, 1861; *A. gestri* Parona, 1889, *A quadrilobata* Linstow, 1908; *Polydelphis waterstoni* Baylis, 1921, *P. sewelli* Baylis et Daubney, 1922, *Hexametra anguinea* Wu et Hu, 1938, *Ophidascaris natricis* Yamaguti, 1935; *O genoheteromegala* Kreis, 1938; *O. microspicula* Kreis, 1938; *Polydelphis dalmatina* Kreis, 1940; *Hexametra daehlholtzii* Kreis, 1944; *Polydelphis najae* Mozgovoy, 1953, *H. multicornis* Mozgovoy et Romanova, 1965; *H. bozkovi* Moravec, 1966; *H. dagestanica* Markov, Khonyakina et Grigor'eva, 1972.

Host. *Bitis arietans* Wagl (fam. Viperidae)
Localization: intestine.
Locality. Zambia (autumn 1986) (snake died shortly after being imported to Prague in Czechoslovakia).
Occurrence: a total of 35 nematodes (12 adults and 23 larvae) were found in a single snake examined.

Description: Larger brownish nematodes, males smaller and more slender than females. Lips slightly wider than long, provided with dentigerous ridges Interlabia

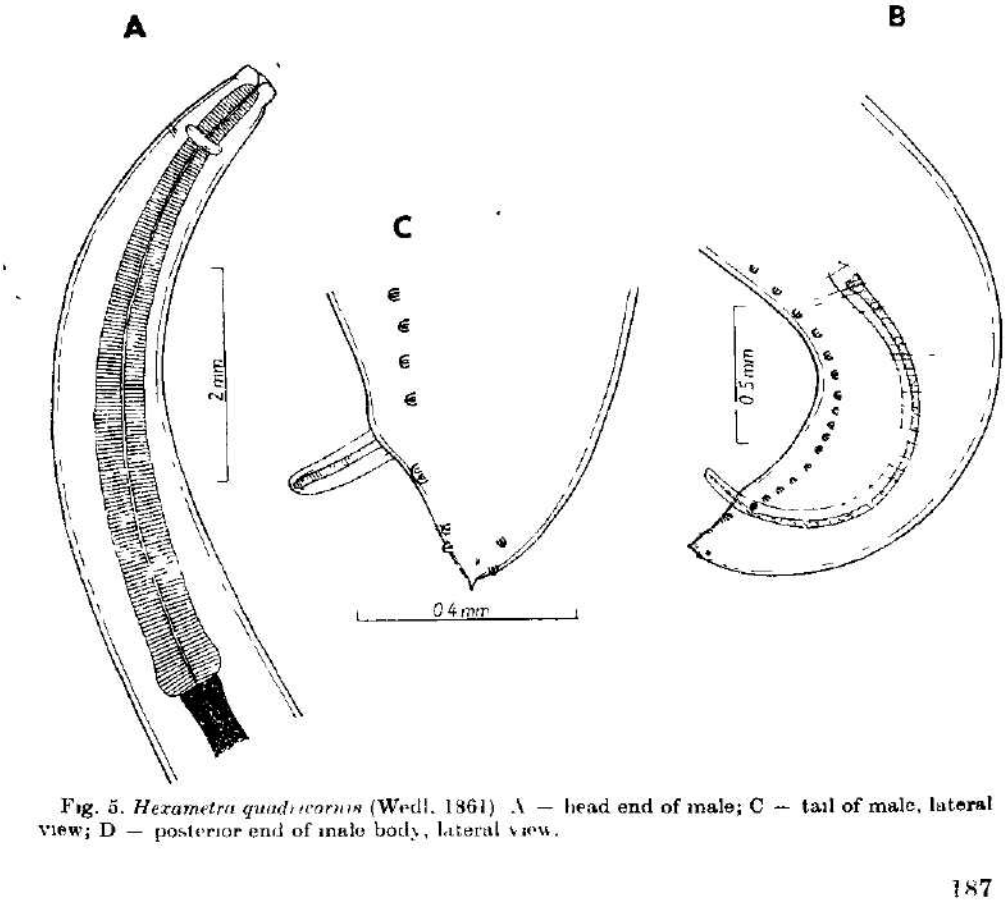

Fig. 5. *Hexametra quadricornis* (Wedl, 1861) A — head end of male; C — tail of male, lateral view; D — posterior end of male body, lateral view.

absent. Lateral alae in form of low ridge extending along lateral lines in middle oesophageal region. Nerve ring encircling oesophagus near its anterior end, excretory pore situated slightly below nerve ring level. Short intestinal caecum present in some specimens.

Male (5 specimens): Length of body 45.56–95.34, maximum width 0.95–2.18. Length of lips 0.122–0.190. Oesophagus measuring 4.62–6.56. Nerve ring and excretory pore 0.517–0.911 and 0.523–0.918, respectively, from anterior extremity. Tail conical, 0.272–0.313 long, with small terminal cuticular spike (length 0.015). Spicules with two alae, 1.29–2.18 long. Preanal papillae numerous (about 35 pairs). Postanal papillae: 3 pairs of subventral (first being double) and 2 pairs of subdorsal papillae present. Lateral phasmids near tip of tail.

Female (3 specimens): Length of body of gravid females 109–130, maximum width 2–3. Length of lips 0.190–0.245. Oesophagus measuring 4.45–4.65. Nerve ring and excretory pore 0.753–0.816 and 0.763–0.825, respectively, from anterior extremity. Tail rounded, 0.590–0.612 long, with small cuticular terminal spike. Vulva situated near middle of body, 5.90–6.70 from anterior extremity. Undivided uterus spreading into six uteri. Size of eggs 0.090–0.096 × 0.075–0.084.

Comments: – A detailed redescription of *H. quadricornis* including its most important morphological features was provided by Baruš and Kornalík (1963); their material originated from *Vipera russeli* imported from India to Czechoslovakia and kept in captivity for six years and from *Bitis gabonica* that had been autopsied four years after its import from Africa. Later the systematic status of this species was revised in detail in the papers by Petter (1968) and Sprent (1978). According to the latter author, *H. quadricornis* is a frequent parasite of a number of elapid, viperid and colubrid snakes that is widely distributed in Africa, Southern Europe, Eastern Mediterranean, India, Malaya, China and Indonesia. Originally this parasite was described from Egypt from *Naja haje*, but from Africa it was reported also from several other countries from other hosts snakes, including *Bitis arietans* (see Sprent 1978). This is the first report on this species from the territory of Zambia.

Fam. Physalopteridae Railliet, 1893

6. *Pseudabbreviata amaniensis* (Sandground, 1928) (Fig. 6)

Syn.: *Physaloptera amaniensis* Sandground, 1928; *Abbreviata benoiti* **Hörchner et Weissenburg**, 1965; *A. cyanogasteri* Horchner et Weissenburg, 1965.

Host: *Agama cyanogaster* (Rüppell) (fam. Agamidae).
Localization: large intestine.
Locality: Copperbelt region, Zambia (spring 1976).
Prevalence: in 1 out of 2 *A. cyanogaster* examined (intensity 3 specimens).

Description: Medium sized nematodes. Head end provided with two lateral pseudolabia, each of them bearing two well developed submedian papillae and one amphid. Each pseudolabium armed with a big externolateral tooth and smaller submedian teeth, two on each side; internolateral tooth and denticles between externo-lateral tooth and angle of mouth not observed, but may be present (no *en face* views were prepared). Head end bearing cervical cuticular inflation. Buccal cavity well developed. Oesophagus distinctly divided into short anterior muscular portion and long posterior glandular portion. Nerve ring encircling oesophagus near its base. Excretory pore and deirids approximately at level of junction of muscular and glandular portions of oesophagus.

Male (1 specimen): Length of body 15.98, maximum width 0.490. Cervical inflation 0.435 long, its thickness 0.081. Length of lips 0.041. Length muscular oesophagus 0.299, that of glandular oesophagus 3.13. Nerve ring, deirids and excretory pore 0.299, 0.381 and 0.394, respectively, from anterior extremity. Spicules unequal. Left spicule well sclerotized, slender, 0.321 long and 0.012 wide. Right spicule broader, less sclerotized, measuring 0.126 × 0.018, with narrowed distal tip. Tail conical with rounded end, pericloacal region with many small cuticular verrucae. Caudal vesicula well developed. Three pairs of preanal and one pair of postanal large pedunculate papillae present, first pair being shifted somewhat more ventrally. Two pairs of smaller subventral pedunculate papillae, situated close to each other, present at mid-length of tail, and last pair of subventrals located in front of tail tip; one unpaired small ventral sessile papilla present near right papilla of last subventral pair. In pericloacal region, one pair of preanal and one pair of postanal sessile papillae present; additional unpaired median sessile papilla present in front of cloacal opening, being situated at level of precloacal sessile papillae.

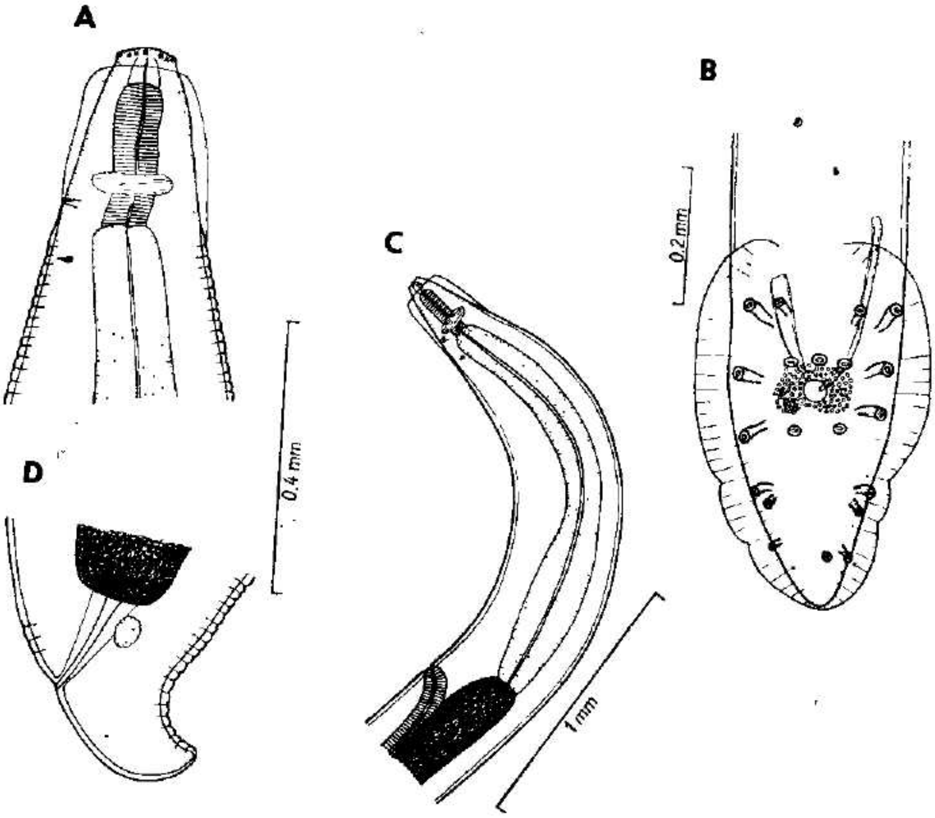

Fig. 6. *Pseudabbreviata amaniensis* (Sandground, 1928). A — head end of female; B — tail of male, ventral view; C — anterior end of female body; D — tail of female.

Female (2 specimens): Length of body of young females 11.79—12.85 maximum width 0.598—0.612 Cervical inflation 0.299 long and 0.040 thick in one specimen and indistinct in another one Length of lips 0.027. Length of muscular oesophagus 0.231—0.285. that of glundular oesophagus 1.77—2.27. Nerve ring, deirids and excretory pore 0.218—0.258, 0.354—0.405. and 0.258—0.394. respectively. from anterior extremity. Vulva situated 2.18—2.86 from anterior end of body. Uterus without eggs. Tail conical, 0.177—0.244 long

Comments: — The present state of the taxonomy of physalopterids is unsatisfactory and the group would require a revision in the future. In 1968, Lichtenfels and Quigley erected a new genus *Pseudabbreviata* based on a new species. *P. nudamphida*. from a "lizard" in Ghana, Africa. This is closely related to the genus *Abbreviata* Travassos, 1920 and. as it has correctly been pointed out by Sharpilo (1976), the features used by Lichtenfels and Quigley (1968) to separate *Pseudabbreviata* from *Abbreviata* are doubtful, because they are currently found in *Abbreviata* species too Nevertheless, Sharpilo (1976) retained *Pseudabbreviata* as a valid genus, but he newly diagnosed it, differing it from *Abbreviata* mainly by the extent of the verrucose region in the male, the length of spicules and the shape of eggs But in our opinion, also these differences seem to be insufficient to separate genera and they should be considered to characterize rather a definite morphological group of congeneric species However. until a detailed taxonomic revision is carried out in this nematode group. we use *Pseudabbreviata* in the concept of Sharpilo (1976); this is followed also by Hasegawa and Otsuru (1984).

Besides the type species of *Pseudabbreviata*. Sharpilo (1976) transferred additional 9 species to this genus, mostly the parasites of agamids. Another species of this genus was recently described by Hasegawa and Otsuru (1984) from Japan

Until now. several morphologically similar *Abbreviata* species have been described from African *Agama* spp.: *A. britanica* Skrjabin. 1916. *A. pallaryi* (Seurat, 1917) *A. amaniensis* (Sandground. 1928). *A benoiti* Horchner et Weissenburg, 1965. *A cyanogasteri* Horchner et Weisseburg. 1965, *A euzebii* Le-Van-Hoa. 1962, *A. golvani* Le-Van-Hoa. 1962, and *A. nyassae* Fitzsimmons. 1964. similar species have been described from African geckoes (*A polydentata* (Walton. 1932)) and "lizards" (*A gracilis* (Ortlepp. 1922). *P. nudamphida* Lichtenfels et Quigley. 1968); some of these species were later transferred by Sharpilo (1976) to *Pseudabbreviata*. Unfortunately. some species descriptions are inadequate and. in our opinion. not always taking into account a possible intraspecific variability of some morphological features (e g . in the structure of lip denticles, arrangement and number of caudal papillae. etc). In this situation we consider it reasonable to assign the specimens of the present material to the species *P. amaniensis* (Sandground, 1928), a species described from *Agama mossambica* from Tanzania (see Skryabin et Sobolev 1964). Contrary to the original description of *P. amaniensis*. the present specimens possess cervical inflation and submedian teeth. their deirids are situated a little more posteriorly. and the left spicule is slightly longer. These differences may be due to some inaccuracies in observation and to the intraspecific variability of these nematodes.

In 1965. Hörchner and Weissenburg described two new *Abbreviata* species. *A. benoiti* and *A. cyanogasteri*. from *Agama cyanogaster* from Congo. i.e. from the same host species from which also specimens of the present material originated Differences in the arment of pseudolabia were believed to be the main distinctions between the two species. *A. benoiti* was differentiated from *A.* (= *P.*) *amaniensis* principally on the basis of a somewhat longer left spicule. In our opinion, these features may be variable within a species and, therefore, we consider both *A. benoiti* and *A. cyanogasteri* to be conspecific with *P. amaniensis*. It is probable that some other related species from Central African agamids are conspecific too.

Similar to *P. amaniensis* are also *P. pallaryi* (Seurat, 1917) described from *Agama bibroni* from North Africa (Morocco) and *P. gracilis* (Ortlepp, 1922) from a "lizard" from Uganda, which may well be identical with the first species. To establish their conspecificity, it would be necessary to study more numerous topotypic materials. The first *Abbreviata* species reported from *Agama* sp. from Africa (East Africa) was *A. britanica* Skrjabin, 1916; unfortunately, its description was based on nongravid females only and, accordingly, its relation to *P. amaniensis* remains uncertain.

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ANOPLOCEPHALOIDES CF. LEMMI (CESTODA), PARASITE OF RODENTS OF THE GENUS LEMMUS IN THE USSR

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Abstract: Material of tapeworms of the genus *Anoplocephaloides*, obtained from dissections of rodents of the genus *Lemmus* from the Taimir peninsula (USSR) was elaborated. Evaluations of the morphological characters showed that the specimens lay in the vicinity of the species *A. lemmi* (Rausch, 1952). They differ namely in the following characters: a higher number of segments in relation to the body length, external morphological strobilae, segmented neck, surface of the cirrus and number of testes.

HISTORICAL ANALYSIS

In literature, the species *Anoplocephaloides lemmi* (Rausch, 1952), originally described as *Paranoplocephala lemmi*, is given as a parasite of lemmings in the holarctic region.

Gubanov and Fedorov (1970) found *Paranoplocephala lemmi* in *Lemmus obensis* in Yakutsk. In their study they described their own material from which it is evident that the specimens they found differed from the original description in some aspects, e.g. length of neck, spineless cirrus.

Rausch (1976) re-classified this tapeworm species to the genus *Anoplocephaloides* Baer, 1923. He studied new material from Alaska and reported that the species *A. lemmi* is a hostspecific parasite of *Lemmus sibiricus* (brown lemming). Rausch (1976) does not provide a description of the newly studied material, but the table given for tapeworms of the genus *Anoplocephaloides* which have wedge-shaped strobilae, shows that the data differ from data of 1952, i.e. the body length, maximum body width, number of strobila segments, maximum length of the cirrus sac and position of the uterus.

Ryzhikov et al. (1978) present the species *A. lemmi* by its original name, i.e. *Paranoplocephala lemmi*. Their description corresponds fully with the description given by Rausch (1952), Ryzhikov et al. (1978) referred to the study of Savelev (1975) as concerns the findings in the USSR.

Shalayeva (1981) reported the finding of *P. lemmi* (= *A. lemmi*) in *Lemmus sibiricus* and *Discrostonyx torquatus* from the Taimir peninsula, without any description.

Tenora et al (1984) and Genov and Georgiev (1988), in accordance with the opinion of Rausch (1976), stated that the species "lemmi" belongs to the genus *Anoplocephaloides* Baer, 1923.

MATERIAL AND METHODS

The following material was investigated for the purposes of the present study:

(1) *Paranoplocephala lemmi* Rausch, 1952, host *Lemmus trimucronatus alascensis*, leg. Rausch 1952, holotypus slide No. 37355, 1 specimen, loc. Point Barrow, Alaska.
(2) *Paranoplocephala lemmi* Rausch, 1952, host *Lemmus sibiricus* (indicated as *Lemmus obensis*), leg. Shalayeva 1981, loc. Taimir, 6 fully gravid and 6 not fully gravid specimens. The material from Taimir was also studied using a scanning electron microscope (SEM). The tapeworms were fixed in 10 % formaldehyde and then dehydrated through an ethanol series and subjected to ultrasound for one minute in absolute ethanol. Then they were critical point dried, mounted on a double-side tape, coated with gold and examined in a Jeol JSM-S1 microscope.

RESULTS

Anoplocephaloides cf. *lemmi* (Rausch, 1952)

Host: *Lemmus sibiricus*. Taimir peninsula

Description (measures given in mm): Strobila long, i.e. 7.2.—13.5 (average 9.96). Maximum width 4.0—6.4 (average 5.33) attained near posterior end. Strobila at first widens wedge-wise to about one third of the length of the strobila, then slightly narrows, after which it again widens to the maximum width of the strobila. This second widening occurs approximately at 2/3 of the length. The terminal gravid segments distinctly narrow after the second widening of the strobila, viz in all the specimens measured in this study (Plate I,* Figs. 2—4). The segments are craspedonte (Plate IV, Fig. 16). The length/width ratio in mature segments is 1 : 2.16. There are, on average, 7.5 segments per 1 mm of strobila length. Segments number ranges between 62 and 83 (average 74), The scolex is 1.28 to 1.90 wide (average 1.45) Suckers large, rounded, with well-developed muscles. The neck is not developed, segments differentiation begins virtually immediately behind the head (Plate II, Figs. 5—9).

Ventral longitudinal excretory canal about 0.060 wide. Genital pores unilateral, situated near the middle of segment margin (Plate IV, Fig. 16). Testes rounded to globular, 35—46 in number (average 41), 0.058—0.062. Testes situated in the aporal half of segment, at the aporal margin extending to the ventral excretory canal, in some segments extending beyond this canal. Cirrus sac strongly developed, pear-shaped, 0.436—0.655 long (average 0.598), maximum width 0.249—0.280 (average 0.278). Protruding cirrus variable in shape, either extending wedge-wise towards the strobila (this cirrus has small spines) or in a form when the diameter of the cirrus over the whole protruding length is nearly the same and is not spiny (Plate III, Figs. 11—14, Plate IV, Figs. 17—18). Vesicula seminalis externa and interna are well evident. Uterus typical for the genus *Anoplocephaloides*, in some segments paases beyond the ventral longitudinal excretory canal. Average size of eggs 0.057—0.053, pyriform apparatus well developed, embryo about 0.017 large.

DISCUSSION

Compared with the known morphological-anatomical data about the species *A. lemmi* (see Tab. 1), the present material shows some differences.

(1) Morphology of body, metric data

Strobila of tapeworm is wedge-shaped. Compared with typical material, the difference lies in the body length/width ratio (see Tab. 1 and Plate I, Figs. 1—4). Also

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* The Plates I-IV will be found at the end of this issue.

the connection of the scolex with tapeworm strobila is different. **Rausch** (1952) stated that "Scolex strongly set off from thin neck". Also **Gubanov** and **Fedorov** (1970) stated that "Skolex ot strobili četko otgraničen nebolšoj šejkoj". Using the SEM (and also the optical microscope) it was found that strobilation occurred immediately behind the scolex and that the scolex was not strongly set off from the thin neck (Plate II, Figs. 7—9). Optical microscope examinations revealed that strobilation was not always evident immediately behind the scolex. Examinations of such specimens in the SEM proved that even though evident segments ate not always formed behind the scolex, strobilation is always indicated and the neck is *not* developed (Plate II, Figs. 8, 9). *The ratio between the total* number of segments of the strobila and the total length of the strobila is also reflected in the external morphology of the body. Compared with specimens given by **Rausch** (1952) and **Gubanov** and **Fedorov** (1970), the present specimens are shorter on average and also actually and they also have, on average and actually, a larger number of segments.

(2) Length of cirrus sac, character of cirrus

In his *material*, **Rausch** *(1952, 1976)* presents great differences in the length of the cirrus sac (i.e. 0.30—0.72 : 0.90). **Gubanov** and **Fedorov** (1970) reported 0.24—0.38; in the present material it was between 0.44 and 0.65. As concerns the character of the cirrus, **Rausch** (1952) stated that the cirrus was provided with inconspicuous spines. **Gubanov** and **Fedotov** (1970) found cirrus without spines. SEM studies of the present material show that in some specimens the cirrus has spines, in others it has not. We must note that in this case they were not shedding spines (Plate III, Figs. 12—14; Plate IV, Figs. 17, 18). In addition, we proved a different morphology of the protruding cirrus, from pear-like to an irregular tubulose formation (see Plate VI, Figs. 11—14; Plate IV, Figs. 16—18).

(3) Number of testes and their situation

To date, only specimens with a relatively similar number of testes were known, i.e. in the material from Alaska and from the USSR (ranging from 56 to 73, see Tab. 1). In our material we did not find more than 46 testes, the number ranging between 35 and 46 testes. The position of the testes is variable. **Rausch** (1952, 1976) stated that they extended from the middle of the vitelline gland. **Gubanov** and **Fedorov** (1970) reported that they extended from the posterior end of the vitelline gland. The former author found that the testes were situated at or just beyond the excretory canals. In material from the USSR, the latter authors found that the testes lied only between the excretory canals. Our findings were similar to those of **Rausch** (1952, 1976).

(4) Uterus and its situation

Rausch (1952) and also **Gubanov** and **Fedorov** (1970) reported that the uterus did not pass laterally beyond the ventral canals. **Rausch** (1976) found that the uterus may or may not overlap the longitudinal excretory canals. The situation in our case is similar.

(5) Comparison with the related species *A. kontrimavichusi* Rausch, 1976

This species parasites in *Synaptomis borealis*. Our material comes close to this species only in the length of the body (*A. kontrimavichusi* 9.5—11.5 : our material 7.2—13.5).

Tab. 1. Characteristic features of *Anoplocephaloides lemmi* : *Anoplocephaloides cf. lemmi*

Autor	Rausch, 1952	Gubanov et Fedorov 1970	Rausch, 1976	own data
Length of strobila	10–20	12–15	16–20	7.2–13.5
Maximum width	3–4	5–6	5–6.5	4–6.4
Number of segments	68–79	56–70	71–94	62–83
Width of scolex	1–1.6	0.96–1.38	1.2–1.5	1.28–1.9
Last mature segment	—	—	31–43	34–45
Maximum length of cirrus sac	0.30–0.72	0.24–0.38	0.90	0.44–0.66
Number of testes	56–73	58–67	56–73	35–46
Distribution of testes	middle of vitelline gland to or just beyon exer. canals	to excretory canal	middle of vitelline gland to or slightly beyond	in some segments beyond excretory canals
Uterus	not pass laterally beyond ventral canal	not beyond excr. canal	middle of segment, may or may not overlap long. excret. canals	may or may not overlap long. excretory canal
Eggs	0.051–0.067 long 0.041–0.056 wide	0.056	0.051–0.067 long	0.050–0.068

CONCLUSION

Results are presented obtained in investigations of material of tapeworms of the genus *Anoplocephaloides* found in *Lemmus sibiricus* in the USSR. In their morphological-anatomical and metric characters they only approximate the descriptions which Rausch (1952, 1976) and Gubanov and Fedorov (1970) had given for the species *A. lemmi* (Rausch, 1952).

It markedly differs from descriptions of the holotype of the species *A. lemmi* reported by Rausch (1952): in the length of the body, presence of strobilation behind the scolex (without neck), number of testes, position of uterus and character of cirrus. For morphological-metric data given by Rausch (1976) for the species *A. lemmi* the main differences are: in the length of the body, maximum length of cirrus sac and character of the cirrus. From the description of *A. lemmi* as given by Gubanov and Fedorov (1970) it markedly differs: in the length of the body, maximum length of the cirrus sac and its character, distribution of testes, presence of segmentation behind the scolex (without neck), number of testes and situation of uterus. It resembles the related species *A. kontrimavichusi* Rausch, 1976 in the length of the body only. The body surface, segmentation of body, surface of cirrus and its shape are documented on SEM photographs.

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ULTRASTRUCTURAL STUDIES OF FISH EGG MEMBRANE

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Abstract. In Acipenseridae, Salmonidae, Cyprinidae and others the structure of egg membrane differs in related species and tends to display convergences in distant families. Egg membrane can be used for bioindication of anthropogenic influence (food ration of parents in captivity, means used for deadhesation, polution by chemical detergents e.t c.) and for testing of the environment for fish development.

Primary productivity of biocenoses is one of the most dramatic criterion for the polution of natural environment. It can be estimated on the basis of biometry, which is most sensitive to anthropogenic influence. in particular seeds and pollen can be used in the case of terrestrial environment (Krivolutsky et al., 1986). In aqueous conditions apart from the primary fish productivity, we propose to use fish egg membrane before and after fertilization for the same purpose.

MATERIAL AND METHODS

The development of ultrastructural level of egg membrane investigation with the aid of scanning electronic microscope greatly increased the possibilities of diagnostics in respect to a number of parametres: Taxonomic, ecological, anthropogenic. Complex egg membrane ultrastructural studies were carried out on 9 species from 4 families of fish (Acipenseridae, Pleuronectidae, Cyprinidae, Salmonidae) from normal and anthropogenic environment. They were published in the microphoto atlas (Vorobyeva, Rubzov, Markov, 1986). These studies were continued by the Institute of Evolutionary Morphology and Ecology of Animal (USSR Academy of Sciences) together with the Zoological Institute (ČSAV, Brno) on 9 species of Cyprinidae, 4 species of Salmonidae and one species of Esocidae from Bohemia and Moravia. The results were published in a series of papers (G. Gaidushek, V. Rubzov, 1983 – 1985).

RESULTS

Ultrastructural features of egg membrane belonging to phylogenetically distant and affined species from Middle Europe are characterized by some common particularities. They are: presence of two shells – primary (zona radiata) and secondary which may be adhesive ("chorion") – pierced by a system of transport canals, ending at the surface by outlet pores (Fig. 1)*.

The thickness of both membranes the distinctness of the boundary between them (especially after fertilization) the number of layers, the orientation branching and internal structure of the transport canals, the morphology of the surface (the adhesivity of the outside shell, the lack of processes and folds, the density and pattern of the outlet pores) vary in different species. Despite the fact that those characteristics are subjected to individual variability and convergences in distant species, they can be used as certain blocks of features for diagnostics on the species, generic and familiar levels. In particular, five morphotypes have been defined in the atlas on the basis of such blocks. For instance, the sturgeon morphotype (Fig. 1A) is distinct in its three layer membrane, with massive outer chorion and two internal layers ("fibrilar"), pierced by radial canals (zona radiata). However, certain structural variants can be distinguished inside this morphotype Thus in some sturgeons (sturgeon. *sevruga, white sturgeon,) the eggs are unitype: they have* almost uniform size and smooth exterior surface with minute pores (Fig. 2). At the same time egg shells of the sterlet apart from pores display multiple processes (Fig 3). This difference can be probably accounted for by ecological particularities. Sturgeon, sevruga, white sturgeon lay their eggs during mass spawning in large portions The smooth surface of the eggs is favourable for their distribution through the spawning site by currents of water, and this is reflected in their survival. Sterlet spawns small portions of eggs in places with very fast current and in this case the processes slow down the egg's progress through the aquatoria.

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* Figures 1 – 13 will be found at the end of this issue.

Analogous processes with different functions are present in the eggs of whitefishes *Coregonus lavaretus pidschian* (Fig. 4), *Coregonus albula* (Salmonidae) and of some Cyprinidae (Fig. 5).

Apart from sturgeon, the secondary membrane can be identified only in some species. In particular it is weakly represented in unadhesive pelagic eggs (place, tropical species, for instance cichlids) and in the eggs which are usually buried in gravel (for instance those of the salmon). In general, we come to a conclusion, that ultrastructural particularities of membranes can be used as one of the characteristic in species specification and also in taxonomy and prognostic fish ecology.

DISCUSSION

The ultrastructural studies have revealed that the membranes can reflected changes in the life of the species and biocenosis in a very short time. The membranes also accumulated the changes which took place in a sequence of generations, namely the conditions of the parent's environment and the state of their gonads This can be proved by the influence of food ration on the quality of the membrana. In *Cyprinus carpio* the carbo-hydrate ration (Fig 6) practically maintains the normal condition of the membrane. But in the case of protein ration (Fig. 7) the membrane becomes twice as thick, mainly due to the changes in the secondary membrane. The resistance of the shell grows and larval death during cleavage decreases.

The membranes accumulate the pollutives and serve as a site for detergents used in oil mining (for instance, ML-72) which take the form of druses (Fig. 8) or spike-crystals. All of these substances influence the state of the membrane differently in different concentrations. The nature of their influence depends not only on the concentration of industrial waste, but also on the species particularities. There is some difference between the eggs before and after fertilization. For instance, PAS-G changes the microstructure of *Cyprinus* eggs considerably, their volume and wet weight increases and the resistance of their membranes falls. Continuous influence and increase in the concentration of formulae can lead to increase of the pores in size and to dissociation and to separation of the secondary membrane from the primary one as we can see in Acipenseridae (Figs 9. 10) As a result, the resistance of the membrane is lost and this can mean lethal consequences for the offspring, and devalue the eggs as food product. The cement panels, sometimes introduced into the breeding ponds can have deadly effect on the sturgeon eggs. The egg absorbs water and increases three times in size The external surface becomes dissociated, the pores are enlarged and the layers disappear (Fig. 11)

The state of the membrane can serve as a good test when choosing the substance for deadhesation Particularities of the species must be taken into account when choosing quantity and the time of treating Some substances must be excluded Thus, talkum powder was for a long time used to deadhesate the membranes *Cyprinus* eggs. However, the ultrastructural studies showed that it closes the pores (Fig. 12) and blocks the circulation. Other substances are used: artezian water with mud, running water, water with milk, tanin, urea after Woinowitch. The latter is particularly used in Czechoslovakia, where milk is sometimes added to this substance. This solution considerably changes the cyprinid membranes, increases the volume and wet weight of eggs and lower their resistance. Those methods must be chosen which do less harm to the membrane or oven give it more rigidity. The future is with tanin and milk, at least this is the case with *Cyprinus* eggs.

Finally, the fast temperature changes which cause considerable enlargement of pores do much harm to the membranes (Fig. 13), and the membrane loosens and loses stratification.

We come to a conclusion that a number of factors influence the ultrastructure of fish egg membranes:

1. History of the species (phylogeny).
2. Conditions of ancestral environment (in the recruit past). Food ration, gonad forming factors, spawning time.
3. Direct influence of the aqueus environment — concentration of harmfull solutions, rearing condition for the eggs (until hatching) in fish harms, natural and artificial spawning sites. Conditions of early ontogenesis.

The fact that egg membranes have obvious adaptive significance reveals great horizons in ultrastructural studies. They can be used for investigations on the state of natural ichthyocenosis, for bioindication of polution and estimation of their fitness for rearing of eggs, methods of deadhesation e.t.c.

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EARTHWORMS (OLIGOCHAETA, LUMBRICIDAE) FROM THE HIGH TATRAS

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Abstract The faunistic and ecological research of earthworms (Lumbricidae) was realized in the years 1967—1969 in the regions of the Belianské, High and Western Tatras, Czechoslovakia Altogether 19 forms of earthworms were found to occur in this region. The richest in the above species was the region of the Western Tatras (17 forms), next the High Tatras (14 forms) and the Belianské Tatras (11 forms). *Dendrobaena alpina alpina*, *Dendrobaena octaedra*, *Octolasium lacteum* and *Eisenia lucens* are the most abundant species The associations of the individual altitude zones from the submontane up to the alpine zone have been also observed. In the submontane zone species from cultivated soils (*Allolobophora caliginosa caliginosa*, *Allolobophora rosea rosea*, *Lumbricus terrestris*, *Octodrilus transpadanus*) prevailed. In the montane zone the species *Octolasium lacteum*, *Dendrobaena octaedra* and *Eisenia lucens* were of the greatest dominance. The subalpine zone is characterized by the species *Dendrobaena alpina alpina*, *Octodrilus argoviensis* and *Dendrobaena octaedra*. Limited number of species live in the alpine zone, *Octodrilus argoviensis*, *Dendrobaena octaedra*, *Dendrobaena alpina alpina* and *Eisenia spelea* are typical here. Remarkable of the species found is the earthworm *Octodrilus argoviensis*, which is rather rare in our country In addition, the find of the so far undescribed form of *Eiseniella tetraedra* is mentioned

INTRODUCTION

The earliest information about earthworms from the Tatra region is from Nusbaum (1985, 1986) who had collected the material predominantly from the Polish part of the High Tatras, namely from the surroundings of Zakopane. However, in some species he suggested their distribution also in other basins of the Tatras. This autor discovered together 10 species of earthworms. The first collections from the Slovak part of the High Tatras were undertaken by Černosvitov (1930) who mentioned 7 species in his work; later he added to their list one more species (Černosvitkov, 1935). Some of this finds are remarkable from the faunistic and zoogeographic point of view, extending as they did substantially the knowledge about the Lumbridicae family on the territory of our country. Zisci (1965) checking the material from K. Wessely, which is deposited in Linz museum, mentions also two species collected in the Tatras. Plisko (1965) brings a critical review of the earlier information on earthworms from the Polish part of the Tatras and she adds the results of her own research from some localities in the Tatras. She observed 8 species here.

Our research of the earthworms in the region of the Tatras began in 1967 and continued in the years 1968 and 1969 Some occasional collections are even older. Beside the author, also Dr. A. Dudich, Ing. G. Buček, O. Ptáček, Ing. S. Čepelák, Dr. L. Barabas and Ing. I. Dančák took part in the collecting. The management of the Tatran National Park in Tatranská Lomnica enabled and supported our work. Some results of this research were published in the years 1977 and 1980

Table 1. Survey of older earthworm finds in the Tatras region

Species	Authors			
	Nusbaum (1893, 1896)	Černosvitov (1930, 1935)	Zicsi (1965)	Plisko (1965)
Allolobophora				
rosea	+			+
caliginosa	+			+
Eisenia				
eiseni		+		
foetida	+			
lucens				+
spelea		+		
Eiseniella				
tetraedra tetraedra		+		+
Octolasium				
lacteum	+			+
Dendrobaena				
alpina	+	+	+	+
handlirschi rhenani		+		
octaedra	+		+	+
rubida rubida	+	+		+
rubida tenuis		+		
Lumbricus				
castaneus	+			
rubellus	+	+		
terrestris	+			

The aim of our work was to gain more complete knowledge about the earthworm fauna in this little explored but very interesting region.

We directed our attention also at the observation of ecology of the individual species and tried to explain some zoogeographic relations, too.

NATURAL CONDITIONS OF THE STUDIED AREA

The West Carpathians reach the highest altitude in the region of the Tatras. These are divided into the Western Tatras and the Eastern Tatras (Lukniš, Plesník, 1961). The Eastern Tatras fall into the High Tatras and Belianské Tatras. Our material includes beside the mentioned massives also the representatives of foothills of the Choćské montains which extends W of the Western Tatras.

The geological structure of the Tatras, similarly as in other Mesozoic crystalline mountains, is asymmetrical. The crystalline core (granit, gneiss, and crystalline shales) covers two thirds of their total area forming the High Tatras and prevalent part of Western Tatras. The Belianske Tatras belong by their origin to the cover series and consist of various Mesozoic rocks (quarzite, clayey shales, dolomite limestones and dolomites). These rocks appear partly also in the Western Tatras. Some further facts relating their geological development are also significant for the development of the fauna in the Tatras. The orogenetic processes caused alternative depressions and rising of this region, however since the later Tertiary dry land appears here definitely, while in lowland areas on the periphery of the Carpathians sea basins sill persisted. The second significant fact was the existence of the Tatra's glaciers which arose here as a result of general hibernation in the Pleistocene considerably influencing this area not only from the viewpoint of its geomorphology but also from the aspect of the development of its living nature.

Climatic conditions are of alpine character (Roubal et al., 1963). Average temperatures, precipitations and other indices depend first of all on altitude above sea level and therefore they vary rapidly in this extremely height-zoned area. Average annual temperature in Poprad (683 m altitude) is 5.9 °C, at Štrbske pleso (1,330 m altitude) 1.5 °C, whereas Lomnický štít

(2,334 m altitude) has average annual temperature −3.7 °C. Similar variation is also found in the annual precipitations from 620 mm in Poprad to 1,855 mm at Lomnický štít. Also, in the highest localities of the Western Tatras the average temperatures are under the freezing point, whereas in basins they reach 5 – 6 °C. Precipitations keep within 700 to 2,000 mm per year.

A complex of ecological factors enables to divide the region of the Tatras into the following zones (Pacanovský et al., 1967):

Submontane zone (the zone of cultivated steppe)

It spreads in the altitude of 700 – 950 m from Liptovský Hrádok to Kežmarok. It covers mostly plain or slightly undulating areas, mostly with fluvio glacial or loess cover. In parts there occur sandstones, slates and islets of limestone. Annual precipitations reach here 620 – 850 mm, average annual temperatures 5.2 – 5.9 °C. Podzolous soils prevail from soil types, in higher localities there occur ochre yelow forest soils. Prevailing woody plants are here pines, birches, spruces, alders and willows which crate canopies only in parts. Major part of this zone is covered by agriculturrally utilized soils with cultures of cereals, potatoes, and fodder crops. Especially meadows and pastures are frequent, quite damp in parts.

Montane zone (forest zone)

It spreads in the altitude of 800 – 1,550 m and covers the greater part of the Tatras. There are great differences in the geological structure, mainly between the Belianské Tatras on one hand and the High and Western Tatras on the other. The Belianské Tatras consist mainly of Mesozoic limestones, while the High and Western Tatras are characterized by the tatran's granite. Annual precipitations come up to 850 – 1,100 mm, average temperatures range between 2 and 5 °C. Prevailing are forest brown soil and podzols, in the Belianské Tatras also brown and grey rendzinas. The forests are considerably height-zoned; with prevailing spruce stands and incurrent larch strips in higher altitudes plus pines in the lower timberline. There appear also maple, birch and alder, and in the area of Belianské Tatras fir and beech.

Sub-alpine zone (zone of dwarf-pine)

It spreads in the altitudes from 1,550 to 1,700 m. Average temperature is 1.4 to 0 °C, total precipitation amounts to 1,500 mm annualy. Vegetation period lasts only 5 weeks. Geological structure is similar to that of the montane zone with prevailing humus podzols and grey forest mountain soils, in the Belianské Tatras grey and brown rendzinas. The soil profile also contains 10 – 15 cm thick sward (with bilberries or grasses) on smear humus layer which is 5 – 15 cm thick. The surface abounds in boulders. The canopy is made up by dwarf-pine with sporadically occuring spruce, stone pine, rowan, and willow. In the lower part of the zone the stand is continuous, becoming thinner in higher parts until it takes the form of islets. The interspace is covered by bilberries and cowberries, heath and various grasses.

Alpine zone (the alpine meadow zone)

It appears in the altitude of 1,750 to 2,200 m. Mean annual precipitation is about 1,700 mm, average temperature between −0.8 and −2.0 °C. Local soils belong to greybrown and blackgrey lawn type, in the Belianské Tatras to grey-black rendzinas, which often turning to peat. Prevalent vegetative cover consists of grasses (*Deschampsia flexuosa*, *Juncus trifidus*, *Poa alpina*, and other), from higher plants mainly cowberry (*Vaccinium vitis-idaea*), blueberry (*Vaccinium myrtillus*) and *Potentilla aurea*.

Subnival zone (the zone of rock debris and cliffs)

Covers the highest areas of the High Tatras (above 2,200 m) with the characteristic steep ridges and peaks. Mean annual temperature here is −2 to −3.8 °C, total precipitations reach 1,800 mm. The minimum vegetation cover is limited only to small areas with humus layer.

MATERIAL AND METHODS

In order to fulfil the aim of our work we had to gain material from as many localities in all basic biotopes of this region as possible. We began with systematic collection in 1967 in the region of Belianske Tatras, during the next year we worked in the eastern part, and in 1969 in the western part of the High Tatras. We gained the greatest part of the material during the spring months, which are the most favourable for earthworm collection.

In the alpine zone the collecting is very laborious, laying high demands on the physical performance of workers, and the work does not bring such quantitative effect as in lower regions. It is necessary to look for specific sites, where the earthworms can live in alpine conditions, and these sites are, especially in higher altitudes, very sparsely distributed in the area.

Where possible, we dug the soil through to gather the arthworms; however, in most cases only the work with a small shovel was possible, to examine roots of plants, space under stones, residues of rotting wood and herbs. The worms obtained were preserved in 80 % alcohol. Altogether 1,479 adult and 823 juvenile individuals were obtained in 82 samples from 73 localities.

The Tables 1–6 forming a part of this paper use the following abbreviations. n — number of individuals, D — dominance of species in %, F — frequency of species in %. The nomenclature follows Zicsi (1982). Names of genera which occur very often in the text were abbreviated as follows: A. — *Allolobophora*, El. — *Eiseniella*, O. — *Octolasium*, Oc. — *Octodrilus*, E. — *Eisenia*, D. — *Dendrobaena*, F. — *Fitzingeria*, L. — *Lumbricus*.

SURVEY OF THE STUDIED LOCALITIES

The High Tatras

Submontane zone

1. Svit, 700 m, 19-9-1964, meadow at the river Poprad: *A. caliginosa caliginosa* 8 individuals, *A. rosea rosea* 6 ind.
2. Gerlachov, Cezháj, 750 m, 14-9-1964, moist forest: *A. caliginosa caliginosa* 3 ind., *O. lacteum* 6 ind., *D. alpina alpina* 1 ind., *F. platyura depressa* 2 ind.
3. Veľká at Poprad, 650 m, 11-10-1962, moist meadow: *El. tetraedra tetraedra* 5 ind., *L. rubellus* 16 ind.
4. Tatranská Lomnica, 850 m, 25-10-1961, coniferous forest: *E. lucens* 2 ind., *L. terrestris* 2 ind., juvenile 2 ind.

Montane zone

5. Vyšné Hágy, 1,500 m, 19-9-1964, meadow with coniferous trees: *E. lucens* 2 ind., *D. alpina alpina* 1 ind., *D. octaedra* 2 ind., *L. rubellus* 7 ind.
6. Tatranská Lomnica, 950 m, 25-4-1968, at a brook in a spruce forest: *A. rosea rosea* 2 ind., *O. lacteum* 6 ind., *El. tetraedra tetraedra* 4 ind., *E. lucens* 7 ind., *D. octaedra* 2 ind., *L. rubellus* 1 ind.
7. Tatranské Matliare, 1,000 m, 23-6-1967, spruce forest: *E. lucens* 12 ind., *D. octaedra* 4 ind., juvenils 7 ind.
8. Hrebienok, 1,250 m, 28-6-1968, environs of Bilikova chalet: *A. caliginosa caliginosa* 18 ind., *D. alpina alpina* 2 ind., *D. octaedra* 4 ind., *L. rubellus* 11 ind., juvenile 108 ind.
9. Štrbské pleso, 1,350 m, 20-9-1964, moist coniferous forest: *E. lucens* 8 ind., *D. alpina alpina* 1 ind., *D. octaedra* 5 ind., *L. rubellus* 5 ind., juvenile 2 ind.
10. Valley of the Veľký Studený brook, 1,400 m, 13-9-1964, stony banks overgrown with grasses and coniferous trees: *A. rosea rosea* 1 ind., *D. alpina alpina* 8 ind., *D. octaedra* 2 ind., *L. rubellus* 6 ind., juvenile 12 ind.
11. Chalet Kamzík, 1,350 m, 28-6-1968, marshy small meadow in the forest: *O. lacteum* 37 ind., *E. lucens* 6 ind., *D. octaedra* 5 ind., juvenile 21 ind.
12. Studenovodské waterfalls at the chalet Kamzík, 1,200 m, 24-6-1968, alluvia at the waterfalls: *E. lucens* 6 ind., *D. alpina alpina* 8 ind., *D. octaedra* 1 ind., *L. rubellus* 6 ind., juvenile 6 ind.
13. Veľká Studená valley, under the Slavkovský waterfall, 1,450 m, 25-6-1968, grassland: *D. octaedra* 1 ind., juvenile 1 ind.

Subalpine zone

14. Valley of the Velický brook, 1,600 m, 19-9-1964, stony banks of the brook with grass vegetation: *A. rosea rosea* 2 ind., *O. lacteum* 1 ind., *D. octaedra* 1 ind., *L. rubellus* 5 ind., juvenile 1 ind.
15. Mlynická valley, 1,650 m, 25-6-1969, humose layers in the bank of the waterfall Skok: *D. alpina alpina* 8 ind., *D. rubida rubida* 1 ind., juvenile 13 ind.
16. Kežmarok s Zelené pleso, 1,550 m, 22-6-1967, margins of a snow field in dwarf pine: *E. lucens* 5 ind., *D. alpina alpina* 27 ind., *D. octaedra* 10 ind., *D. rubida tenuis* 2 ind., *D. vejdovskyi* 2 ind., juvenile 11 ind.

Table 2. Survey of species representation in the studied regions (n — number of individuals, D — dominance, F — frequency)

Species	High Tatras			Western Tatras			Belianské Tatras			All regions		
	n	D	F	n	D	F	n	D	F	n	D	F
Allolobophora antipai tuberculata				1	0.4	7				1	0.1	1
A. caliginosa caliginosa	30	5.5	14	51	19.8	53	12	1.8	9	93	6.3	30
A. rosea rosea	12	2.2	14	47	18.2	60	8	1.2	16	67	4.5	23
Octolasium lacteum	75	13.8	17	44	17.1	73	91	13.3	53	210	14.2	41
Octodrilus argoviensis				4	1.6	7	82	12.1	22	86	5.8	9
O. transpadanus				1	0.4	7				1	0.1	1
Eiseniella tetraedra tetraedra	9	1.7	5	54	21.0	14	64	9.5	9	127	8.5	8
Eisenia lucens	70	13.0	40	11	4.3	14	50	7.3	38	131	9.2	34
E. parva				1	0.4	7				1	0.1	1
E. spelea	13	2.4	5							13	0.9	2
Dendrobaena alpina alpina	146	26.9	54	2	0.8	14	119	17.5	62	267	18.0	50
D. octaedra	93	17.2	71	22	8.5	40	106	15.6	56	221	14.9	60
D. rubida rubida	15	2.8	17	3	1.2	21				18	1.2	12
D. rubida tenuis	10	1.8	9	1	0.4	7	77	11.3	34	88	5.9	18
D. vejdovskyi	5	0.9	5	1	0.4	7	22	3.2	25	28	1.8	13
Fitzingeria platyura depressa	2	0.4	3	3	1.2	14				5	0.3	4
F. platyura montana				3	1.2	7				3	0.2	1
Lumbricus rubellus	60	11.0	25	8	3.1	29	49	7.2	44	117	7.9	33
L. terrestris	2	0.4	3							2	0.1	1
Total	542			257			680			1479		
Juvenile individuals	341			92			390			823		
Number of samples	35			15			32			82		
Number of localities	29			14			30			73		
Number of species (forms)	14			17			11			19		

17. Kežmarok s Zelené pleso, 1,550 m, 22-6-1967, in the soil and plant debris at the bank of the lake. *E. lucens* 5 ind., *D. alpina alpina* 16 ind., *D. octaedra* 9 ind., *D. rubida tenuis* 7 ind, *D. vejdovskyi* 3 ind , juvenile 23 ind.
18. Popradské pleso, 1,550 m, 26-6-1969, spruce forest: *A. caliginosa caliginosa* 1 ind., *O. lacteum* 1 ind., *D. alpina alpina* 3 ind., *D. octaedra* 8 ind , *D. rubida rubida* 6 ind , *L. rubellus* 3 ind, juvenile 17 ind.
19. Popradské pleso, 1,550 m, 20-9-1964, stony slope with coniferous stand: *D. octaedra* 6 ind, *D rubida tenuis* 1 ind .
20 Dell of Zlomiská at Popradské pleso, 1,650 m, 26-6-1969, in rotting wood. *D. octaedra* 5 ind, *D. rubida rubida* 5 ind., juvenile 7 ind.
21. Velické pleso, 1,760 m, 13-9-1964, alluvia at the tarn *D. alpina alpina* 2 ind., *D. octaedra* 5 ind . juvenile 2 ind
22. Malá Studená valley at Ohnisko, 1,600 m, 26-6-1968, grassland, sporadically spruces and dwarf pine: *E. lucens* 8 ind . *D alpina alpina* 3 ind., *D octaedra* 11 ind., *D. rubida rubida* 2 ind , juvenile 5 ind.

Alpine zone

23. Furkotská valley, 1,600 m — 2,000 m, 25-6-1969, at various places: without finds.
24. Hincové pleso, 1,900 m, 24-6-1969, humous layers in moist rock wall: *E. spelea* 12 ind, *D. alpina alpina* 11 ind., *D. octaedra* 4 inc., *D. rubida rubida* 1 ind., juvenile 31 ind
25. Velické pleso, 1,800 m, 25-6-1968, humous layers in moist rock wall of the waterfall Večny dážď: *E. lucens* 7 ind., *D. alpina alpina* 2 ind., *D. octaedra* 4 ind., juvenile 2 ind.
26. Zbojnícke pleso, 2,000 m, 25-6-1968, in the meadow under the stones: *D. octaedra* 1 ind, juvenile 1 ind.
27 Vareškove pleso, 1,850 m, 25-6-1968, under the rotting grass in the small meadow: *D alpina alpina* 21 ind., *D octaedra* 4 ind , juvenile 38 ind
28 Malá Studená valley under Tery schalet, 1,900 m, 26-6-1968, in moist layers of rotting grass and humus in the rock wall: *E. lucens* 2 ind., *D. alpina alpina* 7 ind., *D. octaedra* 1 ind juvenile 7 ind.
29. Batizovské pleso, 1,900 m, 26-6-1968, moist grass areas in the wall: *D. alpina alpina* 25 ind, juvenile 24 ind

The Belianské Tatras

Submontane zone

30. Ždiar, 850 m, 22-5-1965, mised forest: *A caliginosa caliginosa* 7 ind., *O. lacteum* 3 ind, *E. lucens* 2 ind., *D octaedra* 1 ind., *L rubellus* 4 ind , juvenile 4 ind.
31 Ždiar, 855 m, 21-8-1965, meadow at the brook: *A. caliginosa caliginosa* 4 ind , *A. rosea rosea* 1 ind., *D. octaedra* 1 ind , *L rubellus* 13 ind.,
32. Ždiar, 800 m, 22-5-1965, meadow. *A caliginosa caliginosa* 1 ind., *A. rosea rosea* 3 ind , *O. lacteum* 1 ind.

Montane zone

33. At the chalet Plesnivec, 1,200 m, 22-7-1967, fir forest: *O. lacteum* 8 ind., *E. lucens* 4 ind, *D alpina alpina* 4 ind., *D. octaedra* 19 ind., *D. rubida tenuis* 10 ind., *D. vejdovskyi* 7 ind, *L. rubellus* 3 ind., juvenile 48 ind
34. At the chalet Plesnivec, 1,200 m, 25-8-1967, meadow: *O. lacteum* 2 ind., *E. lucens* 1 ind, *D. rubida tenuis* 7 ind, juvenile 3 ind.
35. Dell of Sedem prameňov, 900 m, 26-8 and 20-9-1967, at the brook bank: *El. tetraedra tetraedra* 64 ind , *D. alpina alpina* 1 ind. *D. octaedra* 2 ind., *L. rubellus* 1 ind., juvenils 1 ind
36. Dell of Sedem prameňov, 1,200 m, 26-8-1967, fir forest: *O. lacteum* 2 ind., *E. lucens* 1 ind, *D. alpina alpina* 11 ind., *D. octaedra* 1 ind., *D rubida tenuis* 2 ind., *L. rubellus* 3 ind., juvenile 24 ind.
37. Valley of Biela voda above the Šalviový prameň, 1,300 m, 23-6-1967, moist forest: *E lucens* 16 ind., *D. alpina alpina* 2 ind., *D. rubida tenuis* 3 ind., juvenile 7 ind.
38. Šalviový prameň, 1,100 m, 23-6-1967, bank of brook: *E. lucens* 1 ind., *D. octaedra* 9 ind, *D. rubida tenuis* 4 ind., juvenile 2 ind.

Subalpine zone

39 Skalne Vráta, 1,650 m, 24-8-1987, fir forest: *Oc argoviensis* 7 ind , *O. lacteum* 3 ind., *E lucens* 10 ind., *D alpina alpina* 1 ind., *D. octaedra* 3 ind., *D. rubida tenuis* 4 ind., *L. rubellus* 3 ind, juvenile 13 ind.

40 Skalné Vráta, 1,700 m. 24-8-1967, meadow. *Oc argoviensis* 6 ind., *D. octaedra* 3 ind.. *D. rubida tenuis* 4 ind., *L. rubellus* 5 ind.. juvenile 11 ind.

41. Skalne Vráta, 1,600 m, 21-9-1967, moist humus with grass· *Oc. argoviensis* 11 ind.. juvenile 8 ind.

42. Bujači, 1,650 m, 20-6-1967, meadow: *A. rosea rosea* 21 ind., *O lacteum* 6 ind., *D. alpina alpina* 3 ind., *D. octaedra* 4 ind., juvenile 29 ind.

3. Zadné Jatky, 1,500 m., 20-6-1967, at former chalet in the meadow: *D. alpina alpina* 2 ind ,
4 *D. octaedra* 1 ind.. *D vejrodovskyi* 3 ind., juvenile 5 ind

44. Jatky, 1,700 m. 20-6-1967, at snow field in the meadow: *D alpina alpina* 12 ind.. *D. octaedra* 3 ind , juvenile 24 ind.

45. Bujači, 1,500 m. 20-6-1967, moist humus, at a group of trees (fir, rowan-berry): *O. lacteum* 4 ind , *E lucens* 1 ind.. *D. alpina alpina* 20 ind.. *D octaedra* 3 ind., *D. rubida tenuis* 3 nd , *D. vejdovskyi* 5 ind., *L. rubellus* 1 ind., juvenile 42 ind.

46. Kežmarská chalet. 1,600 m, at the ski-tow, 19-7-1967, snow field on the meadow. *O. lacteum* 25 ind.. *E. lucens* 1 ind., *D alpina alpina* 3 ind., *D. octaedra* 2 ind.. *D. rubida tenuis* 5 nid . *L. rubellus* 1 ind.. juvenile 13 ind.

47. Kopské sedlo, 1,600 m, 21-6-1967, moist meadow: *O. lacteum* 5 ind., *E. lucens* 12 ind , *D. alpina alpina* 6 ind , *L. rubellus* 2 ind., juvenile 3 ind.

48. Behanská kopa, 1,600 m, 22-6-1967, at former chalet· *A. rosea rosea* 1 ind , *O lacteum* 11 ind , *D. rubida tenuis* 5 ind . *D. vejdovskyi* 5 ind . *L. rubellus* 5 ind., juvenile 15 ind.

49. Behanská kopa, 1,650 m, 19-6-1967, moist suršoundings of the brook: *D. alpina alpina* 1 ind., *D. vejdovskyi* 3 ind.. juvenile 2 ind.

50. Predné Meďodoly, 1,600 m. 22-6-1967, meadow at an avalanche cave-in. *A. rosea rosea* 1 ind., *O lacteum* 5 ind.. *E. lucens* 1 ind.. *D. alpina alpina* 13 ind . *D octaedra* 10 ind., *D vejdovskyi* 1 ind., juvenile 15 ind.

51. Behanská kopa, 1,700 m. 22-6-1967. at a snow field in a meadow: *O. lacteum* 1 ind.. *D. alpina alpina* 2 ind . *D. octaedra* 15 ind., juvenile 33 ind

52. Zadne Meďodoly, 1,500 m, 21-6-1967, meadow: *O. lacteum* 2 ind.. *D alpina alpina* 5 ind., *L. rubellus* 1 ind , juvenile 15 ind

53 Behanská kopa, 1,650 m, 22-6-1967, meadow: *D. alpina alpina* 10 ind., juvenile 20 ind.

54. Zadné Meďodoly, 1,500 m, 21-6-1967, coniferous forest: *O. lacteum* 6 ind., *L alpina alpina* 14 ind

Alpine zone

55. Ždiarská vidla, 2,000 m, 21-6-1967, moist soil at a waterffall: *Oc. argoviensis* 18 ind , *O. lacteum* 7 ind., *D. alpina alpina* 2 ind., *D. octaedra* 13 ind , *D. rubida tenuis* 30 ind., *L. rubellus* 5 ind., juvenile 23 ind.

56. Kopske sedlo, 1,750 m, 21-6-1967, soil with low grass stand: *D. alpina alpina* 7 ind , *D octaedra* 4 ind., juvenile 3 ind.

Alpine zone

57. Bujačí, 1,980 m, 24-8 1967, meadow on zonal soils: *Oc. argoviensis* 20 ind., *D octaedra* 12 ind., juvenile 18 ind.

58. Zadné Jatky, 2,000 m. 20-6-1967, meadow on zonal soils: *Oc. argoviensis* 17 ind , *L rubellus* 2 ind., juvenile 8 ind.

59. Hlúpy, 1,850 m, 20-6- 1967, humose layers on detritus boulders: *Oc argoviensis* 3 ind., juvenile 12 ind.

Western Tatras

Submontane zone

60. Lisková, 620 m, 10, 11-7-1963, meadow at the river Váh: *A. caliginosa caliginosa* 4 ind., *O. lacteum* 3 ind.. *El. tetraedra tetraedra* 23 ind , juvenile 3 ind.

61. Lisková, 650 m, 9-7-1963, Liskovská cave *O. lacteum* 4 ind.,

62. Lisková, 630 m, 10-7-1963, meadow on arable land: *A. rosea rosea* 10 ind., *O. lacteum* 3 ind.

63. Lisková, 650 m. 10-7-1963, small pine forest: *A. caliginosa caliginosa* 6 ind , *A. rosea rosea* 4 ind., *O. lacteum* 1 ind.

64. Lisková, 620 m, 11-7-1963, pasture at the river Váh: *A. caliginosa caliginosa* 15 ind , *E. parva* 1 ind., juvenile 9 ind.

65. Liptovská Mara, 670 m, 11-5-1965, meadow: *A. antipai tuberculata* 1 ind., *A. rosea rosea* 12 ind., *O. lacteum* 13 ind.. *D. octaedra* 1 ind., *F. platyura montana* 3 ind , juvenile 39 ind.

66 Kvačany, 700 m, 29-4-1966, meadow at a brook bank: *A. caliginosa caliginosa* 4 ind., *A. rosea rosea* 2 ind., *O. lacteum* 5 ind., juvenile 8 ind.

67. Oravice, 800 m, 29-4-1966, beech-spruce forest *A. caliginosa caliginosa* 9 ind., *A. rosea rosea* 2 ind., *O. lacteum* 3 ind., *Oc. transpadanum* 1 ind., *F. platyura depressa* 3 ind., *D. rubida rubida* 1 ind., juvenile 8 ind.

68. Pribylina, 750 m, 27-6-1969, surroundings of brook at Račkova dolina. *A. caliginosa caliginosa* 10 ind., *O. lacteum* 2 ind., *D. alpina alpina* 1 ind., *D. octaedra* 1 ind., *D. rubida rubida* 1 ind., *L. rubellus* 1 ind., juvenile 6 ind

Montane zone

69. Roháče, Juráňova valley, 900 m, 29-7-1967, alluvia at the brook: A. rosea rosea 1 ind., *Oc. argoviensis* 4 ind., *El. tetraedra tetraedra* 31. ind., *D. octaedra* 2 ind., *D. rubida tenuis* 1 ind., *L. rubellus* 1 ind., juvenile 4 ind.

70. Roháče at the chalet Zverovka, 900 m, 29-4-1966, meadow stand with a spruce: *A. caliginosa caliginosa* 2 ind., *O. lacteum* 8 ind., *E. lucens* 2 ind., *D. octaedra* 1 ind., *D. alpina alpina* 1 ind., *D. rubida rubida* 1 ind., *L. rubellus* 4 ind., juvenile 7 ind.

71 Roháče, Osobitá, 1,5000 m, 28-8-1967, coniferous forest *E. lucens* 9 ind., *D. octaedra* 9 ind., *D. vejdovskyi* 1 ind., juvenile 3 ind.

72. Roháče, Bobrovské sedlo, 1,300 m 27-8-1967, meadow: *A. rosea rosea* 6 ind., *O. lacteum* 1 ind., *D. octaedra* 7 ind., *L. rubellus* 2 ind.

73. Podbanské, 950 m, 27-4-1966, spruce forest: *A. caliginosa caliginosa* 1 ind., *A. rosea rosea* 5 ind., *O. lacteum* 1 ind., *D. octaedra* 1 ind., juvenile 5 ind.

EARTHWORM FAUNA IN INDIVIDUAL REGIONS AND THEIR ECOLOGY

The High Tatras

This region belongs to the central region of the Tatras. Igneous rocks, which are characteristic for their geologic structure, influenced the development of soils, of flora and fauna markedly.

Altogether 14 forms of earthworms were found here. The most numerous include *D. alpina alpina* (dominance D = 26.9 %), *D. octaedra* (D = 17.2 %), *O. lacteum* (D = 13.8 %) and *E. lucens* (D = 13.0 %). The highest frequency is shown by the species *D. octaedra*, *D. alpina alpina*, *E. lucens*, and *L. rubellus*.

The submontane zone is characterized by the species of cultivated soil on one hand and by forest species on the other. *L. rubellus*, *A. caliginosa caliginoa*, *A. rosea rosea*, and *O. lacteum* prevail. We have 9 earthworm forms here. In the montane zone, where also 9 forms of lumbicids occur, is *O. lacteum* (D = 31.0 %) the most numerous species followed by the forest species *E. lucens* and *D. octaedra*. Also *D. alpina alpina* begins to occur more frequently. The species *A. caliginosa caliginosa*, *A. rosea*, and *O. lacteum* occur predominantly around chalets and can be considered imported hosts to this zone. According to the frequency *E. lucens*, *D. alpina alpina*, and *L. rubellus* belong to the most important species.

In the *subalpine zone* there occur 10 forms of lumbricids. *D. alpina alpina* prevails, important are also the species *D. octaedra* (D = 31.2 %), *E. lucens* (D = 10.5 %) According to frequency important are mainly *D. octaedra* (F = 100 %), *D. alpina alpina*, *D. rubida tenuis*, and *E. lucens*. In this zone the earthworms occur mainly in such parts where there are plant debris and the soil is permanently moist. It is mainly on grassy benches under the waterfalls, under rotting grass etc. This part of the Tatras is very poor in earthworms on the whole and in some parts probably they do not occur at all — in Furkotská valley we did not find even one specimen in June 1969 in spite of the fact we dug probes in five places and examined some more suitable stands.

Table 3. Survey of species representation in the individual elevation zones of the High Tatras
(n – number of individuals, D – dominance, F – frequency)

Species	Zone														
	Submontane			Montane			Subalpine			Alpine			All zones		
	n	D	F	n	D	F	n	D	F	n	D	F	n	D	F
Allolobophora caliginosa caliginosa	11	21.6	75	18	8.3	11	1	0.6	11				30	5.5	14
A. rosea rosea	6	11.8	25	4	1.8	33	2	1.1	11				12	2.2	14
Octolasium lacteum	6	11.8	25	67	31.0	33	2	1.1	22				75	13.8	17
Eiseniella tetraedra tetraedra	5	9.8	25	4	1.8	11							9	1.7	5
Eisenia lucens	2	3.9	25	41	19.0	88	18	10.5	33	9	8.8	28	70	13.0	40
E. spelea				1	0.5	11				12	11.8	14	13	2.4	5
Dendrobaena alpina alpina	1	1.9	25	20	9.3	66	59	34.1	66	66	64.7	85	146	26.9	54
D. octaedra				25	11.6	11	54	31.2	100	14	13.7	71	93	17.2	71
D. rubida rubida							14	8.1	44	1	1.0	14	15	2.8	17
D. rubida tenuis							10	5.8	33				10	1.8	9
D. vejdovskyi							5	2.9	22				5	0.9	5
Fitzingeria platyura depressa	2	3.9	25										2	0.4	3
Lumbricus rubellus	16	31.4	25	36	16.7	66	8	4.6	22				60	11.0	25
L. terrestris	2	3.9	25										2	0.4	3
Total	51			216			173			102			542		
Juvenile	2			157			79			103			341		
Number of samples	5			12			10			8			35		
Number of localities	4			9			8			7			29		
Number of species (forms)	9			9			10			5			14		

In the alpine zone there live only 5 species. *D. alpina alpina* (D = 64.7 %) prevails, important are also *D. octaedra* (D = 13.7 %) and *E. spelea* (D = 11.8 %). *E. lucens* is also quite frequent beside the species mentioned. We collected the material solely in rock rifts with grass vegetation and humus soil, wetted by dripping water or by waterfalls. Other types of stands in this zone are almost without earthworms.

The Belianské Tatras

As it results from the previous characteristic, the Belianské Tatras have an individual character when compared with the High Tatras and the Western Tatras which results first of all from differences in geological structure and from factors which depend on it (soil types, vegetation). The analyses of 32 samples from 30 localities of this region gave 11 forms of earthworms.

According to dominance, the species *D. alpina alpina* (D = 17.5 %), *D. octaedra* (D = 15.6 %), *O. lacteum*, *Oc. argoviensis* and others belong to the most numerous. According to the observed frequency, the species *D. alpina alpina*, *D. octaedra O. lacteum*, *L. rubellus*, and *E. lucens* are the most common ones.

In the submonate zone prevail common species, which live in meadows and cultivated soils (*A. caliginosa caliginosa*, *L. rubellus*, *A. rosea rosea*), from the species typical for the forest we found here *D. octaedra* and *E. lucens*. The highest dominance has *L. rubellus*, the highest frequency *A. caliginosa caliginosa*. The species composition corresponds with the character of the area which is utilized mainly as arable land or as forest.

In the montane region prevail the forest species living in dropped leaves and in rotting wood (*D. octaedra*, *D. vejdovskyi*, *D. rubida tenuis*, *E. lucens*). There appears the typical species of higher sites — *D. alpina alpina*. Near water streams the species *El. tetraedra tetraedra* is very numerous, forming a special, so far unknown form in this area.

The highest frequency achive here the forest species and the species *O. lacteum*.

In the subalpine zone *D. alpina alpina* prevails, it has here good conditions in meadows and near brooks in deeper clayey profiles; it has also the highest frequency. Very numerous is also the earthworm *O. lacteum*. the forest species occupy also significant places. At the same time the typical representative of high localities begins to appear here — *Oc. argoviensis*, which is an alpine element. In this zone the earthworms dwell also beneath the snow fields, mainly at the thawing margins and they also crawl on the snow (*D. octaedra*).

The alpine zone is characterized by the presence of the species *Oc. argoviensis*, which has great dominance (D = 41.4 %) and high frequency (80 %). Very numerous is *D. octaedra* and *D. rubida tenuis*; *D. alpina alpina* is less represented here

The Western Tatras

From the geological viewpoint this region is rather variegated as there are various soil, floristic, and faunistic conditions. Although the number of samples taken here was the lowest (15 samples) we found a considerable number of earthworm forms here.

As more samples were taken in the surrounding of brooks, the species *E. tetraedra tetraedra* (D = 21.0 %) prevails in our material. It is necessary to mention the earthworms *A. caliginosa caliginosa* (D = 19.8 %), *O. lacteum* (D = 17.1 %) and *A. rosea rosea* (D = 18.2 %) from further numerous species. According to frequency

Table 4. Survey of species representation in individual elevation zones of the Belianské Tatras
(n — number of individuals, D — dominance, F — frequency)

Species							Zone								
	Submontane			Montane			Alpine			Alpine			All zones		
	n	D	F	n	D	F	n	D	F	n	D	F	n	D	F
Allopbophora caliginosa caliginosa	12	29.2	100										12	1.8	9
A. rosea rosea	4	9.7	66				4	1.3	19				8	1.2	16
Octolasium lacteum	4	9.7	66	12	6.4	72	68	21.9	62	7	5.0	20	91	13.3	53
Octodrilus argoviensis							24	7.7	19	58	41.4	80	82	12.1	22
Eiseniella tetraedra tetraedra				64	34.0	18							64	9.5	9
Eisenia lucens	2	4.9	33	23	12.2	82	25	8.0	31				50	7.3	38
Dendrobaena alpina alpina				18	9.6	72	92	29.6	81	9	6.4	40	119	17.5	62
D. octaedra	2	4.9	66	31	16.5	82	44	14.1	56	29	20.8	60	106	15.6	56
D. rubida tenuis				26	13.9	82	21	6.8	31	30	21.4	20	77	11.3	34
D. vejdovskyi				7	3.7	18	15	4.8	31				22	3.2	25
Lumbricus rubellus	17	41.6	66	7	3.7	54	18	5.8	43	7	5.0	40	49	7.2	44
Total	41			188			311			140			680		
Juvenile individuals	4			85			247			54			390		
Number of samples	3			8			16			5			32		
Number of localities	3			6			16			5			30		
Number of species	6			8			9			6			11		

Table 5. Survey of species representation in individual elevation zones of the Western Tatras
(n — number of individuals, D — dominance, F — frequency)

Species	Zone								
	Submontane			Montane			All zones		
	n	D	F	n	D	F	n	D	F
Allolobophora antipai tuberculata	1	0.7	11				1	0.4	7
A. caliginosa caliginosa	48	31.7	66	3	2.8	40	51	19.8	53
A. rosea rosea	31	20.5	66	16	15.2	40	47	18.2	53
Octolasium lacteum	34	22.5	88	10	9.4	60	44	17.1	73
Octodrilus argoviensis				4	3.8	20	4	1.6	7
O. transpadanus	1	0.7	11				1	0.4	7
Eiseniella tetraedra tetraedra	23	15.2	11	31	29.3	20	54	21.0	14
Eisenia lucens				11	10.4	40	11	4.3	14
E. parva	1	0.7	11				1	0.4	7
Dendrobaena alpina alpina	1	0.7	11	1	0.9	20	2	0.8	14
D. octaedra	2	1.3	22	20	18.9	100	22	8.5	0
D. rubida rubida	2	1.3	22	1	0.9	20	3	1.2	1
D. rubida tenuis				1	0.9	20	1	0.4	7
D. vejdovskyi				1	0.9	20	1	0.4	7
Fitzingeria platyura depressa	3	2.0	11				3	1.2	7
F. platyura montana	3	2.0	11				3	1.2	7
Lumbricus rubellus	1	0.7	11	7	6.6	60	8	3.1	29
Total	151			106			257		
Juvenile individuals	73			19			92		
Number of samples	10			5			15		
Number of localities	9			5			14		
Number of species (forms)	13			12			17		

O. lacteum (F = 73 %) is in the first place, then follow *A. caliginosa caliginosa* and *A. rosea rosea* (F = 53 %), then *D. octaedra* (F = 40 %).

When analysing the earthworm occurrence, we find 13 forms in the submontane and 12 forms in the montane zones of this region. In the submontane zone prevail species from cultivated soils: *A. caliginosa caliginosa* (D = 31.7 %), *O. lacteum* (D = 22.5 %), and *A. rosea rosea* (D = 20.5 %). Forest species have low dominance (*D. octaedra*, *D. rubida rubida*). According to frequency the most important species to be *O. lacteum* (F = 88 %), *A. caliginosa caliginosa* (F = 66 %), and *A. rosea rosea* (F = 66 %). However, here appears also *D. alpina alpina*, a species living regularly in higher altitudes above the sea level.

In the montane zone prevail *El. tetraedra tetraedra* (D = 29.3 %) because of the above mentioned reasons. From further species important are *D. octaedra* (D = 18.9 %) and *E. lucens* (D = 10.4 %). Further forest species *D. rubida tenuis* and *D. vejdovskyi* are also represented. In soils with limestone base we find the species *Oc. argoviensis*. The highest frequency in this zone was found with the species *D. octaedra* (F = 100 %) and also with the earthworm *O. lacteum* and *L. rubellus* (F = 60 %).

EARTHWORM ASSOCIATIONS IN INDIVIDUAL ALTITUDE ZONES

When studing the number of earthworm species represented in individual altitude zones we can observe marked tendency toward the decrease of number of represented forms according to the elevation above sea level. While in the submontane zone there are as many as 15 earthworm species, in the alpine zone we found no more than 9 species.

Certain characteristic changes occur also in the dominance of individual species as depending on zones. It is obvious e.g. in species *A. caliginosa caliginosa*, *A. rosea rosea*, *O. lacteum*, and *L. rubellus* which belong to regular inhabitants of cultivated soils. Only in lower localities we observed lowland species associated with deeper (mainly alluvial) soils; these are the earthworm *A. antipai tuberculata*, *Oc. transpadanus*, *F. platyura*, and *L. terrestris*. The forest species had the highest dominance in the montane and submontane zone. These include mainly *E. lucens* and *D. octaedra*. Besides these can mention mountain species the dominance of which increases in higher altitudes. It is first of all *Oc. argoviensis* which occurs no sooner than in the montane zone and its dominance increases gradually from 0.8 % up to 29 %. Similar tendencies can be seen in the species *D. alpina alpina*, the dominance of which increases gradually from 0.8 % in the submontane zone up to 31 % in the alpine zone. The same holds for the forest species *D. octaedra* which achieved the highest dominance in subalpine zone as well as with related species *D. rubida rubida*, *D. rubida tenuis* and *D. vejdovskyi*.

When analysing the frequency of the given species in individual zones, we come to similar conclusions as in the case of dominance although the tendencies are not so unambiguous in all cases.

Association of the submontane zone earthworms is characterized by the predominance of species living in cultural soils (*A. caliginosa caliginosa*, *A. rosea rosea*, *O. lacteum*). Further there are typical species associated with deeper, clayey soils (*L. terrestris*, *F. platyura*, *Oc. transpadanus*) and/or to river valleys (*A. antipai tuberculata*). This second group has lower dominance but it does not occur in higher zones.

Table 6. Species representation in elevation zones of the Tatras region (n — number of individuals, D — dominance, F — frequency)

Species	Zone											
	Submontane			Montane			Subalpine			Alpine		
	n	D	F	n	D	F	n	D	F	n	D	F
Allolobophora antipai tuberculata	1	0.4	4									
A. caliginosa caliginosa	71	29.3	78	21	4.1	17	1	0.2	4			
A. rosea rosea	41	16.9	45	20	3.9	26	6	1.2	10			
Octolasium lacteum	44	18.2	60	89	17.4	55	70	14.5	25	7	2.9	7
Octodrilus argoviensis				4	0.8	7	24	4.9	6	58	24.0	27
O. transpadanus	1	0.4	4									
Eiseniella tetraedra tetraedra	28	11.6	12	99	19.5	16						
Eisenia lucens	4	1.6	19	73	14.7	70	43	8.9	21	9	3.7	9
E. parva	1	0.4	4									
E. spelea				1	0.2	4				12	4.9	5
Dendrobaena alpina alpina	2	0.8	12	39	7.6	53	151	31.2	52	75	31.0	41
D. octaedra	4	1.6	29	76	14.9	64	98	20.3	52	43	17.8	43
D. rubida rubida	2	0.8	7	1	0.2	7	14	2.9	15	1	0.4	5
D. rubida tenuis				27	5.3	34	31	6.4	21	30	12.4	7
D. vejdovskyi				8	1.6	12	20	4.1	18			
Fitzingeria platyura depressa	5	2.0	12									
F. platyura montana	3	1.2	4									
Lumbricus rubellus	34	14.0	34	50	9.8	60	26	5.4	22	7	2.9	12
L. terrestris	2	0.8	8									
Total	243			510			484			242		
Juvenile individuals	79			261			326			157		
Number of samples	18			25			26			13		
Number of localities	16			20			25			12		
Number of species (forms)	15			13			11			9		

The most numerous species of the montane zone is *O. lacteum* (D = 12.4 %). Further species with high dominance include *D. octaedra* and *E. lucens* which are typical forest species and live in rotting wood or in other plant debris. Also other species belong to the forest earthworms, which we have not been observed in the submonate zone (*D. rubida tenuis, D. vejdovskyi*). Species from higher localities begin to appear here, too. However, they are still rare(*D. alpina alpina, Oc. argoviensis*). Lowland species are missing here.

In the subalpine zone prevail the species *D. alpina alpina, Oc. argoviensis, D. octaedra*, and also *O. lacteum*. The dominance of small species of the genus *Dendrobaena* still rises (*D. rubida rubida, D. rubida tenuis, D. vejdovskyi*). Also the forest species *E. lucens* is widespread here. Species from cultivated soils occur only rarely.

In the alpine zone there lives only a limited number of species from which *Oc. argoviensis, D. alpina alpina*, and *E. spelea* can be included into the alpine forms The forest species (*D. octaedra, D. rubida tenuis, E. lucens*) are also significantly represented here, they can be found mostly in plant debris.

SURVEY OF THE DETERMINED SPECIES

Allolobophora antipai tuberculata (Černosvitov, 1935)

We found the only one specimen of this earthworm in the submontane zone. Its occurrence in the Tatras region belong to northernmost localities which are known. It occurs in the region of the middle Rhine and between the eastern Alps and the Black Sea in the region of the river Danube and Dniester. The place of occurrence on the meadow in the wide valley of the river Váh near Liptovská Mara corresponds in its character to meadow and field sites in river valleys.

Allolobophora caliginosa caliginosa (Savigny, 1826)

It occured solely in the submontane and montane zone, in the subalpine zone we found only one specimen. The species in question occurs regularly in meadows and in arable land, less frequently also in mixed forests. In general it is considered to be typical for areas used in agriculture (Graff, 1953, Čekanovskaja, 1960). In the submontane zone it had the highest frequency and considerable dominance (D = 21.6 %). In the montane zone its representation was much lower, only in the surrounding of chalets (Zverovka in the Western Tatras, Bílik's chalet in the High Tatras). The only find belonging to the subalpine zone was from the surroundings of a chalet at Popradské pleso. From the mentioned it results that the earthworm in question appears in higher localities only as a synanthrop species. According to its distribution it belongs to cosmopolitan species which reached all continents.

Allolobophora rosea rosea (Savigny, 1826)

= *Allolobophora jenensis* (Füller, 1952) — Zajonc, 1977; Kasprzak, Zajonc, 1980

Representation of this species in individual altitude zones of the Tatras is characterized by gradualy decrease of dominance, so it does not appear in the alpine zone at all. In the submontane zone this species is the third most numerous earthworm (D = 16.9 %), in the subalpine zone decreased its dominance to 1.2 %. In higher sites it occurs mainly in former pastures and near chalets. It seems that also this species was brought into the higher localities by man. *A. rosea rosea* easily adapts to various ecological conditions and therefore it can be found in localities of various types (Zajonc, 1965, 1970). It is a cosmopolitan species spread all over the world.

Octolasium lacteum (Örley, 1885)

It occurs in all altitude zones, however, its dominance and frequency decrease in dependence on elevation above the sea level. In the High Tatras it reaches the maximum in montane zone, in the Belianské Tatras in the subalpine zone. On the whole it is the third most numerous species in our material. Concerning the dependence of occurrence of this species on soil rich in limestone (Baltzer, 1956; Zicsi, 1959; Perel, 1964), our finds do not prove this correlation. Its dominance in the high Tatras (mainly with granite bottom) is something higher than in the Belinské Tatras, where the limestone bottom prevails. This species is spread all over the world.

Octodrilus argoviensis (Bretscher, 1899)

= *Octolasium croaticum argoviense* (Bretscher, 1899) — Zajonc, 1977. Kasprzak, Zajonc, 1980

The occurrence of this species begins in the montane zone (D = 0.8 %) and it reaches the maximum in the alpine zone (D = 24 %). However, it occurs only in the regions with limestone bottom. Therefore its total dominance e.g. in the Belianské Tatras reaches 12.1 % (in their alpine zone even 41.4 %), while in the studied granite regions of the High Tatras it is missing entirely. The finds from the Western Tatras originate also from limestone formations (Juráň's valley). Detailed information about the ecology of this species is missing. Pop (1947) and Zicsi (1965) observed that it occurs at the waterside in fallen leaves as well as in montane localities in limestone soil. It is spread in Switzerland, Austria and only one find originates from Poland (surrounding of Bielsko-Biala). Besides the Western and Belianské Tatras we have found it also at the village Jasenie in the Low Tatras. Mikulová (1973) listed further localities in Slovakia (Srdiečko beneath Chopok) and from Bohemia (Horská Kvilda in the Bohemian Forest).

Octodrilus transpadanus (Rosa, 1884)

In the region explored only one specimen was found in the submontane zone of the Western Tatras. This species requires thicker clayey profiles and therefore it only rarely reaches higher altitudes.

The autor regards it as a species typical for damp loweland deciduous forests and meadows, mainly of alluvial character. It is spread in central, south and east Europe and also in Asia Minor.

Eiseniella tetraedra tetraedra (Savigny, 1826)

= *Eiseniella tetraedra quadripora* Černosvitov, 1942 — Zajonc, 1980; Kasprzak, Zajonc, 1980

This species occurs only on sides of water reservoirs and streams. To our knowledge it ascends only to the montane zone, we did not find it in higher localities although there are many biotopes suitable for this species here (sides of trans. brooks, etc.). In great numbers it occured especially in the montane zone of the Western and Belianské Tatras. It is spread all over the world.

This species is known to have several forms differing by the position of male genital pores or by their number. In 1942 Černosvitov described the form *Eiseniella tetraedra* mut. *quadripora* with genital pores on 14th and 15th segments. Stop-Bowitz (1969) considers this phenomenon atavistic. In our materials from the area of Belianské Tatras we found specimens which belong to this form together with specimens of typical form. Beside those also specimens with male genital pores on 13th, 14th and 15th segment occur here, too.

Eisenia lucens (Waga, 1857)

It reaches its maximum in the submontane and montane zones, however it belongs to species which reach up to the alpine zone. It lives predominantly in forest stands where we can find it in rotting stumps and wood debris. However, in higher localities it occurs also on sides of water in putrefying grass layers and directly in the humus layer of soil. It is common in forests. The area of its occurrence spreads in central an partially also in south Europe.

Eisenia parva (Eisen, 1874)

The only specimen found originates from the submontane zone of the Western Tatras. In our country this species is so far known only from Estern Slovakia (Zajonc, 1966) and from the Tatras (Černosvitov, 1930). The area of its occurrence spreads in Europe, North America, in central part of Asia, in New Zealand and some other islands.

Eisenia spelea (Tosa, 1901)

The only specimen originates from the montane zone of the High Tatras. Also Černosvitov (1930) mentioned it in this region. This earthworm is known also from Romania, the Ukrainian Republic, and from Italy.

Dendrobaena alpina alpina (Rosa, 1884)

It represents the most numerous species (D = 18 %) with high frequency (F = 50 %) in the area of the Tatras. The montane character of this earthworm is proved by its increasing dominance with rising altitude from 0.8 % in the submontane zone to 31 % in the alpine zone. As far as the individual parts of the Tatras are concerned, it was represented in High Tatras most numerously (D = 26.9 %) and in Western Tatras less numerously (D = 0.8 %). Its typical biotopes in the subalpine zone are the meadow stands, in the alpine zone first of all damp layers of the soil on ledges of rock walls with grass vegetation, rich wetted by dripping water.

This species has so far observed mainly in higher localities (the Low Tatras, the Poľana and the Vihorlat mountains), or in localities possessing cold microclimate. The area of its occurrence spreads in Switzerland, Austria, Italy, Yugoslavia, Romamania, on Crete, in Syria, the Caucasus, in the Transcaucasus, Greece, and Turkey.

Dendrobaena octaedra (Savigny, 1826)

It belongs to the most numerous species in the region of the Tatras and occupies the second place according to dominance. It is most frequent in the High Tatras (D = 17.2 %) and in the Belianské Tatras (D = 15.6 %). Of the three regions studied it is most frequent in the alpine and subalpine zones (D = 17.8 % and 20.3 %).

It lives regularly associated with wood debris therefore it is typical for the forest biotopes. In higher localities it occurs also in rotting herbs, in moss layers etc. It sustains well also low temperatures. We gained living specimens from layers of decayed grass under snow at the edge of a snow field, many individuals crawled on the snow It belongs to species which are widespread; it occurs almost in the whole world It is one of the two species which occur also in unfavourable conditions of Greenland.

Dendrobaena rubida rubida (Savigny, 1826)

It occured only in the Western and the High Tatras where it belonged to rare species. It reached the highest dominance in the subalpine zone (D = 2.9 %) and it occured also in the alpine zone. This species concentrates on rotting wood Generally it is considered to be inhabitant of the moist soils with abundance of organic debris. Its absence from localities in the Belianské Tatras would suggest that it avoids limy soils. It is a cosmopolitan species with large distribution

Dendrobaena rubida tenuis (Eisen, 1874)

The dominance of this form increases with altitude. It did not occur in the submontane zone, in the montane zone its dominance was 5.3 %, in the subalpine 6.4 % and in the alpine 12.4 % It would seem therefore that the higher altitude are favourable for the life of this earthworm. Similarly as the two previous species it occurs in rotting wood and in other plant debris. It is a cosmopolitan species which is spread mainly in montane and submontane regions in our country.

Dendrobaena vejdovskyi (Černosvitov, 1935)

It is found in the subalpine and montane zones in all three regions, in the Belianské Tatras it was most common However, it belongs to rare species according to its occurrence. It lives in upper layers of soil mainly under the moss and under plant debris. It is spread in Austria and Hungary, in our country it lives in the Bohemian Forest, too

Fitzingeria platyura depressa (Rosa, 1893)

Fitzingeria platyura montana (Černosvitov, 1932)

Both forms found in the material demand deep clayey soil profile. Therefore they live mainly in alluvial and loess soils in lower sites. In our collections they occured only in the submontane zone of the High and Western Tatras Both forms live in Romania, Hungary, Austria, and Bavaria, the form *montana* lives in the Ukrainian Republic, in Poland and Italy, too.

Lumbricus rubellus Hoffmeister, 1843

It occured from the submontane up to the alpine zone. Its dominance decreased from 14 to 2.9 % with the elevation above the sea level. It had the highest rate in the material from the High and Belianské Tatras It lives on the soil surface under dropped leaves, in the moss and under rocks, at moist stands It is a cosmopolitan species spread on the whole territory in our country.

Lumbricus terrestris (Linnaeus, 1758)

It belongs to species living on deep clayey soil horizons and on surficient ammount of plant debris. Its occurrence depends first of all on cultivated soils. Therefore it occured in the submontane zone in the studied region and only in small quantity. It is a cosmopolitan species which is spread all over our country in typical stands

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MORTALITY AND RATE OF SURVIVAL OF THE BREAM (ABRAMIS BRAMA) IN THE ORLÍK RIVERINE LAKE BETWEEN 1980—1983 (PISCES)

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Abstract. Mortality and rate of survival were estimated for the bream (*Abramis brama*) in the Orlik riverine lake during the period 1980—1983. Values of the instantaneous total *mortality rate (Z) varied between 0.7225 and 1.2816 and* were calculated out of the abundance of fish in the individual groups. The calculated values characterize older specimens from the Vth age group onward. In 1983 the lowest values (28 %) of the rate of survival were found, the highest (49 %) in 1982

INTRODUCTION

The bream. *Abramis brama* (Linnaeus. 1758) is an important component of the Czechoslovak ichthyofauna. In our riverine lakes it reproduces frequently and belongs to very plentiful fish species. With regard to the economic and angling points of view this species deserves our attention.

A fish population is influenced by two complexes of factors causing mortality. First is the extent of industrial and sportive catches causing industrial (catch) mortality (designated as F - fishing mortality). second comes as a complex of factors, e.g., fish senility. predator influence. disease etc., causing natural mortality (M - natural mortality). Both types of mortality may exist either independently or coexist at the same time.

MATERIAL AND METHODS

The material of the bream examined was collected from the upper part of the Orlík riverine lake near the village of Štědronín, where the river Otava flows into the Vltava. The utility area of Orlík valley lake is 2 400 ha, maximal depth is 74 m. The total volume of the water is $716.56 . 10^6\ m^3$. The length of the swelling of this reservoir is 68 km. The permanent volume of the Orlik riverine lake is $280 . 10^6\ m^3$ (Vlček. 1984).

Numerous material of the bream from the Orlík riverine lake was gained from the day and night seining in May, June and second third of October of the year 1980 Further fishes were caught in May, July. September and October, 1981. Another part of the bream material was acquired in June, September and October, 1982. The last material of the bream was seining in May and June, 1983. In 1980, 2119 specimens (V—XII age class), in 1981 672 specimens (V—X age class), in 1982 673 specimens (V—XI age class), in 1983 315 specimens (VI—X age class) were studied, in total, 3779 specimens.

For netting seine nets were used. 50 m long, 4 and 6 m deep, mesh size 2 × 2 cm and 0.8 × 0.8 cm, and 100 m long, 6 m deep, with meshes of 1 × 1 cm, and 200 m long. 6 m deep, with meshes 3 × 3 m. The maximum part of population of the bream were caught.

In all specimens the body length (longitudo corporis) was measured. The total weights were ascertained. Collected scales were examined using reading apparatus Dokumator DL II. using magnification 17.5.

Mortality was determined by **Ricker's** (1975) method. The estimates of the rate of survival and instantaneous total mortality rate were calculated on the basis of the age distribution of the respective population, which evolves out of the assumption that the decrease of the abundance of individual fish in the population in consecutive age groups is a measure of the mortality rate of the population and as a consequence also its rate of survival. We assume the sample of the fish population which has been caught to be representative and also the relative representation of the age groups in the sample to be close to a real distribution in whole population (**Ricker**, 1975; **Pivnička**, 1981; **Holčík**, 1966; **Vostradovský**, 1969).

The total number of specimens in the individual age groups was considered to be a representative *sample. The instantaneous total mortality was calculated out of the* decreasing number of individuals in the age groups (on a natural logarithm scale) for the total population under study in the respective year.

The parameter Z is called the instantaneous mortality rate; N — number of fish in a year cless; A — annual mortality rate; S — rate of survival (S = —ln Z); t — interval of time (year).

RESULTS AND DISCUSSION

1980

The instantaneous total mortality rate was calculated for the complete collection of Vth—XIIth age groups during 1980 according to the relation:

$$\ln N_t = 12.117 - 0.9391\ t$$

the result being a high correlation coefficient $r = -0.97378$ (Fig. 1), the value of Z was 0.9391. The rate of survival was 39 %, the annual mortality rate 61 %. The values of the instantaneous mortality rate (Z), rate of survival (S) and annual mortality rate (A) for the individual age groups are expressed in Table 1.

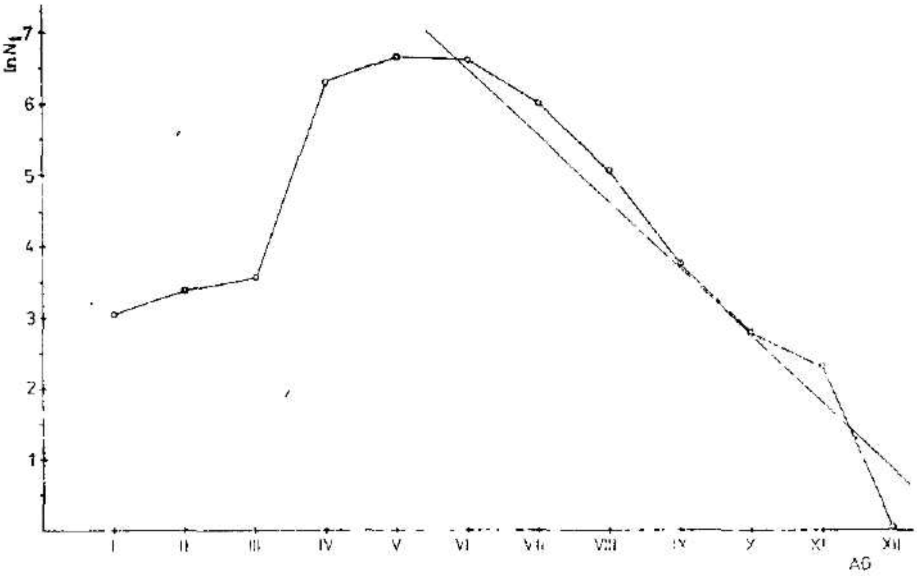

Fig. 1. The instantaneous (total) mortality rate (Z) of the bream for age groups VI—XII in the Orlík riverine lake in the year 1980.

Table I. Survey of the instantaneous mortality rate (Z), rate of survival (S) and annual mortality rate (A) of the bream in the Orlík riverine lake in the years 1980 and 1981

Age group	1980 Z	 S	 A	1981 Z	 S	 A
V	0.0361	0.9645	0.0350	1.064	0.345	0.655
VI	0.5982	0.5497	0.4503	0.785	0.456	0.544
VII	0.9619	0.3820	0.6180	1.509	0.221	0.779
VIII	1.2993	0.2727	0.7273	0.761	0.467	0.533
IX	0.9651	0.3810	0.6190	1.944	0.143	0.857
X	0.4700	0.6250	0.3750	—	—	—
XI	2.3025	0.1000	0.9000	—	—	—
XII						

The value of Z changes from the minimum of 0.0361 for the youngest age groups to the value of 2.3025 in the eldest age groups. The rate of survival varies similarly and out of it the annual mortality rate may be calculated Values of S are the highest in the youngest age groups, the minimum value (0.1) was calculated for the eldest age groups.

1981

In 1981, the instantaneous total mortality rate was calculated for the whole collection of Vth—Xth age groups according to the following relation:

$$\ln N_t = 12.116 - 1.1722\, t$$

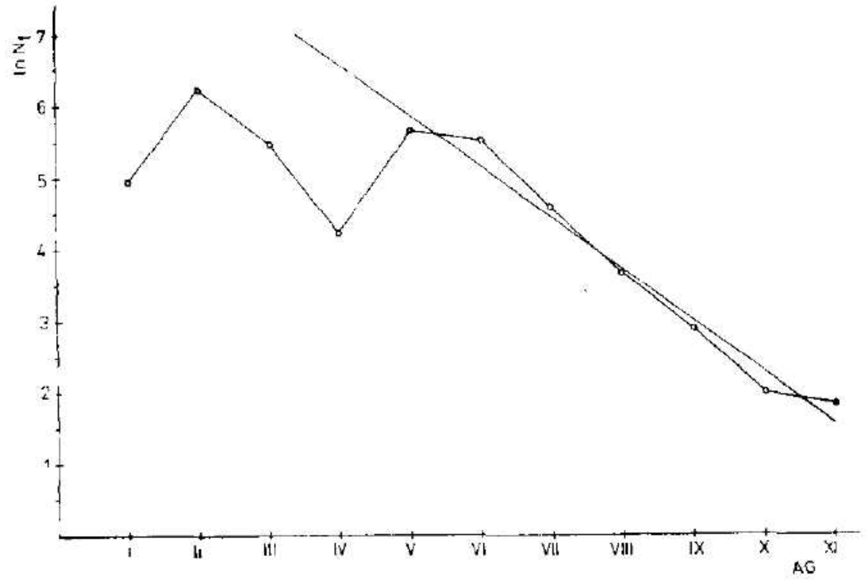

Fig. 2. The instantaneous (total) mortality rate (Z) of the bream for age groups V—X in the Orlík riverine lake in the year 1981.

The correlation coefficient reaches a high value of $r = -0.99104$, $Z = 1.1732$ (Fig. 2). The rate of survival is 31 %, annual mortality rate is 69 %. A survey of the values of all coefficients mentioned are shown in Table 1. Values of the instantaneous total mortality rate vary considerably from 0.761 for the IXth age group to 1.944 for the Xth age group. The rate of survival was highest in the IXth age group, the highest value of the annual mortality rate was found in the Xth age group.

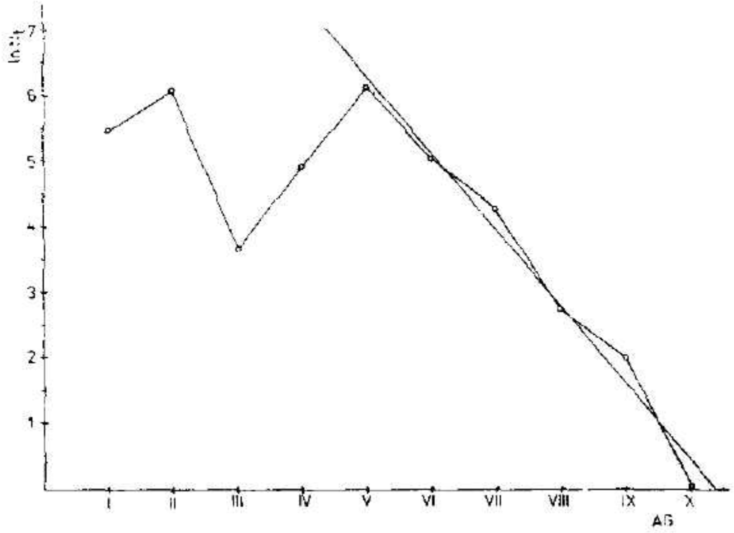

Fig. 3. The instantaneous (total) mortality rate (Z) of the bream for age groups V—XI in the Orlik riverine lake in the year 1982.

1982

In 1982, the instantaneous mortality rate was calculated for the whole collection of age groups (V—XI). $Z = 0.7225$, according to the equation:

$$\ln N_t = 9.464 - 0.7225\, t$$

The correlation coefficient was $r = -0.98792$ (Fig. 3). The instantaneous mortality rate was the slope of the above mentioned relation, the highest rate of survival was $S = 49\,\%$, and the annual mortality rate represented $A = 51\,\%$. Survey of the values in the individual age groups is shown in Table 2. The minimal value of the instantaneous mortality rate was found in the eldest (XI) age group and in the Vth age group. Consequently, the rate of survival was highest also in those two groups.

1983

In 1983, the instantaneous total mortality rate was calculated for the whole collection of VIth—Xth age groups. $Z = 1.2816$, according to the equation:

$$\ln N_t = 13.3162 - 1.2816\, t$$

Table 2. Survey of the instantaneous mortality rate (Z), rate of survival (S) and annual mortality rate (A) of the bream in the Orlik riverine lake in the years 1982 and 1983

Age group	1982			1983		
	Z	S	A	Z	S	A
V	0.159	0.853	0.147	—	—	—
VI	0.957	0.384	0.616	0.749	0.473	0.527
VII	0.899	0.407	0.593	0.911	0.402	0.598
VIII	0.779	0.459	0.541	1.474	0.229	0.771
IX	0.887	0.412	0.588	2.079	0.125	0.875
X	0.154	0.857	0.143	—	—	—
XI						

The correlation coefficient was r = — 0.97749 (Fig. 4). The rate of survival was 28 %, the annual mortality rate equalled 72 %. Survey of the values in the individual age groups is shown in Table 2. The highest value of Z was found for the Xth age group (Z = 2.079). and therefore also the lowest value of the rate of survival. The highest rate of survival was found in the VIth age group (S = 47 %).

In 1983, as in the only of all studied years, a significant rise of the value of the instantaneous total mortality rate (Z) was observed related to the increase of individual age groups. Relationship of the two parameters may be described by the equation: Z = — 2.3391 + 0.4553 t, with a correlation coefficient of r = 0.97425.

The values of the mortality rate in the younger age groups, where the values were not calculated, may be higher due to the effects of predator fishes acti-

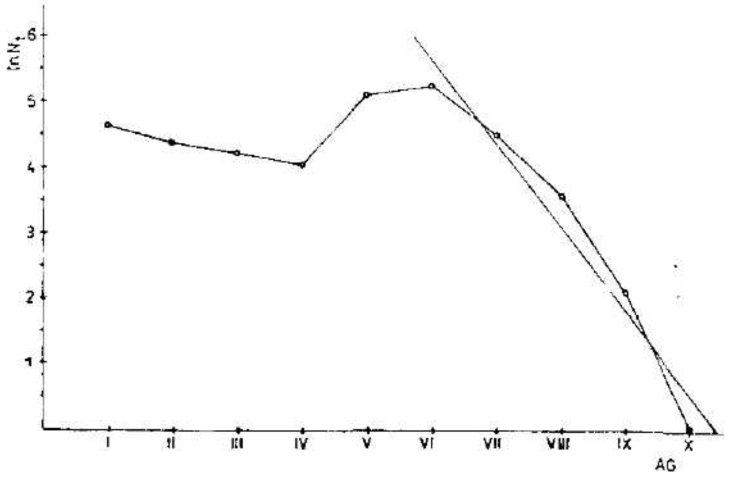

Fig. 4. The instantaneous (total) mortality rate (Z) of the bream for age groups VI—X in the Orlik riverine lake in the year 1983.

vities. The mortality rate is influenced also by changes of the height of the water level of the riverine lake. The youngest age groups of the bream died. The higher mortality of older fish may be caused not only by the natural mortality, but it may be also influenced by angling and by net catches (industrial fishing mortality). The seining of the fishes in the Orlík riverine lake has taken place in the same localities for several years.

Tjurin (1963) cited that in the zero and first age groups the most frequent cause of mortality is the natural mortality. According to Tjurin (1962) the coefficient of the natural mortality is indirectly dependent on the intensity of fishing.

In our region, the bream mortality has been studied up to now only insufficiently. Balon (1963) calculated the average annual mortality rate for breams from the Danube river for the IIIrd age group and elder to be 72 %. Unfortunately he did not work with a more numerous representative sample of the fish population (compare Holčík, 1966). Balon (l.c.) states also the value of the mortality rate for males as 71 % from the third age group onward and for females 65 % from the fifth age group. For the breams of VIIth—XVIth age groups in the Mostiště reservoir, Gajdůšek (1981) found a mortality rate of 50 % for males and 42.8 % for females. Average values of annual mortality rate in the Orlík riverine lake (A = 61, 69, 51, 72 % for the respective years 1980—1983) are near to the values reported for breams from Hungary.

Biró and Garádi (1974) found the following values of mortality for breams from Lake Balaton: Z = 0.9677; the rate of survival was 38 %, and the value of the annual mortality rate was 62 %. The rate of survival vary in the individual age groups between 26—59 %, annual mortality rate vary between 41—74 %.

In the Soviet Union the values of natural mortality are calculated according to the method of Tjurin (1962). The coefficient of natural mortality in the Pljavinskoe reservoir (the Lithuanian Soviet Socialist Republic) on the Daugava river was 21—26 % in other reservoirs (Riga, Kagumsk and the Daugava river) its average value was 24 % (Gaumiga, 1982). Djatlov (1982) reports the coefficient of natural mortality in Ladoga lake to be 17.5 % in 1976. For breams 2—11 years old in Lake Ilmen, Tjurin (1962) found a mortality rate of 40 %. Total mortality rates of breams in the northern part of the Caspian Sea, determined during two time periods, was Z = 0.55 and 0.80 (Lukašov, 1961, cit. by Biró and Garádi, 1974).

Calculations of mortality and survival rates were critically evaluated by Holčík (1966), and also Vostradovský (1969) evaluates the respective methods of calculation, pointing out the individuality of ecological conditions in different localities and their importance for the evaluation of final average values, which is often further complicated by differences between the individual methods of sample collection. A most detailed analysis and description of the various types of calculations and methods is given by Ricker (1975).

The calculated values of survival and moratlity rates in the Orlík riverine lake for fish specimens of the bream from the Vth age groups onward may be compared with the values calculated for Mostiště reservoir (Gajdůšek, 1981) and for the Danube river (Balon, 1963), which characterize older individuals.

SUMMARY

The survival and mortality rates of the bream, *Abramis brama*, in the Orlík riverine lake was studied in the years 1980—1983, in total 3779 specimens.

The calculation of the rate of survival and mortality rate was done on basis of the age composition of the population. A decrease in the number of fish in each of the following age groups reflects the mortality rate of the population and as a consequence also its rate of survival.

The values of the instantaneous mortality rate were calculated for the whole population being taken into account in the extent of the known age groups. The average values vary between 0.7225 (1982) to 1.2816 (1983).

The rate of survival was of the lowest value in 1983 (28 %), the highest in 1982 (49 %), and therefore the resulting maximum value of the annual mortality rate was 72 % in 1983, while the minimal 51 % in 1982. The sample taken in 1983 was the only one, where a rise of the instantaneous total mortality rate (Z) correlated with rising age groups could be found.

Calculated values of survival and mortality rates in the Orlík riverine lake found for the Vth and older age groups characterize older individuals and are comparable with the data from the Mostiště reservoir and the Danube river.

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SHORT NOTE

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THE MORPHOLOGY OF TURBELLARIA AND THE FORMATION OF THE ANATOMICAL AND HISTOLOGICAL SYSTEMS OF METAZOA

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The Turbellaria are a group important for evolutionary morphology. They give many examples useful for understanding of the evolution of the histological organization and main anatomic systems of Metazoa. The formation of the epidermis is observed in Turbellaria. It is traced back to a primitive bordering layer with an irregular, almost parenchymal structure (Beklemishev 1925, 1950). Within the limits of the class, basic trends of the epidermis evolution are revealed. They are the following ones: the formation of different types of the epidermis, the formation of the basal lamina, and sometimes the development of the syncytial state. The main types of the epidermis are found also within the order Acoela. Similar processes are also revealed in the evolution of the turbellarian gastrodermis. In the both cases a characteristic feature of primitive histological systems can be noted, namely the insunk cambium located within the parenchyma. After the processes of epithelization are finished, the remaining inner parenchyma forms muscular, nervous, glandular, and connective tissues. Side by side with the processes of the spatial separation of the histological systems, the delimitation of tissues and organs due to formation of muscular walls and basal laminae is also traced.

Supporting structures and their derivatives (stylets and hooks) also show a spectacular evolutionary picture. They originate on the basis of both intracellular and extracellular materials. The former present different intracellular fibre layers and other local condensations, so called "cell web" (not only the apical fibre layer but also lateral and basal microfilamentous condensations and laminae). They all may occupy a substantial volume in cells and are a possible precondition for keratinization. The latter are: 1) the basal lamina and its derivatives and 2) primitive secretory coatings and cuticles. There are also cases of parenchymal and entodermal supporting formation development (solitary spicules or a spicular armature, the anterior supporting branch of the intestine, the so-called "Kopfdarm"). They are rather rare but very interesting because they show evolutionary trends typical of the Deuterostomia. Thus the Turbellaria show all the morphological spectrum of the various supporting formations, i.e. all the theoretically possible ways of the supporting structure evolution are well represented or at last may be traced.

A wide morphological spectrum is also shown by turbellarian extrusomes, their diversity including both non-capsular (rhabdites and rhabdois) and capsular (sagittocysts) types. The sagittocysts known in a group of *Convoluta* species (Acoela)*) are of particular interest because they give an analogy to the cnidarian nematocysts, only instead of filaments they extruse solid needle-shaped pilots. The diversity of shooting devices is increased by the paracnids which evaginate the tubes formed by cell walls (as in the Microsporidia). Comparable diversity of shooting devices is observed only in protozoan groups. This seems to prove that within a certain group all spectrum of shooting devices arises i.e. exemplifies the initial morphological diversity. Such evolutionary picture implies that a device appears within a group but is not inherited from its ancestors.

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* On the basis of the lecture read in the Department of Zoology, Charles University, Praha, May 16, 1989.

Catching and attaching organs (pharygis, penes probosces) also give an instructive evolutionary picture demonstrating initial morphological diversity within the Turbellaria. They all originate as differentiations of the integument, work in sticking or pinching ways, and show interesting parallel morphological lines as outlined by Karling (1963). There is also a well known scheme of the nervous system evolution within the Turbellaria beginning with a difuse plexal to orthogonal and oligomerous nervous systems with few well developed trunks, the order Acoela showing the greatest morphological diversity. The acoelan nervous system is formed by either external or insunk nervous plexus, or includes different, strange as it may seem odd (9) number of the longitudinal trunks (Ivanov and Mamkaev 1973, Mamkaev 1985; Kotikova 1986).

The Turbellaria give also a good example of the sensillae, eyes and statocysts origin and different ways of their perfections. The eyes originated within this group more than once and from different sources, several of construction types being found in the group. There are some reasons to believe that the statocysts also had a plural origin, the comparison with other lower invertebrates being here very instructive. The statocysts appear to have originated as an adaptation either to swimming (Acoelomorpha), or to the infaunal mode of life (Catenulida, Proseriata).

The Plathelminthes and related groups also give an idea of the formation and evolutionary trends of the protonephridial system. We can see here the formation of different types of the flame cells and different patterns of vessel systems beginning with the independent protonephridia opening out separately. The protonephridial vessel system of the Platyhelminthes (as well as their nervous system) show some definite levels of development and definite types of transformation related to increase of the size and changes in the form of the body.

Turbellaria are the only group which provides the opportunity to understand the formation of the digestive system in the Metazoa. Only the Turbellaria allow to fill in the gap between the spongian and enterozoan evolutionary levels. Here we can obtain an idea of the most important features of the early development of the digestive apparatus (specialization and differentiation of cells, formation of the epithelial intestine). The evolutionary stages represented in the Acoelomorpha are the most instructive here. In this group the following types appear: 1) irregular cellular structure; 2) syncytial stage with retaining phagocytic activity in some species; 3) large central cavity with the walls not epithelial but composed of irregularly arranged cells and their derivatives including small temporary syncytial formations with two or a few nuclei**); more or less epithelialized intestine composed

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[*] Owing to the sagittocysts (as well as to ciliary male copulative organs) this group appears to deserve the rank of family.

[**] This stage has been investigated by Raikova (1987) in *Actinoposthia beklemischevi*. In this species the enzymes are released from the protrusions of the cells which lie in the frontal wall of the cavity and are due to destruction of lateral and frontal cells (apocrine and holocrine types of secretory glands).

of the cells of two types (special gland cells are developed). It is reasonable to believe that the stages listed above illustrate the development of the three forms of organization of digestive system (2–4) which originate from an irregular parenchymal structure (1). The epithelial stage (4) is considered by Smith and Tyler (1985) the initial one. But I cannot quite agree with their opinion because in this case the specialized cells are present. In relation to this problem it is worth mentioning that the processes of the intestine formation are revealed not only in the Acoelomorpha but also in other orders of Turbellaria. The progressive nature of the evolution of the turbellarian digestive system is also supported by the development of the pharynx which is still absent in some Acoela and originates within the group. It is confirmed as well by the fact that the position of the mouth opening which is still stabilized as anterior in the evolution of the Metazoa is still variable in a number of turbellarian group.

The picture of the progressive evolution of the organ systems discussed above is enriched by our knowledge on the structure of the turbellarian genital system. Having compared the evolution of all organ systems in the Turbellaria, we can outline a general picture of the systemogenesis. Any changes in any system result in changes of its elements, number of elements and relation between the elements. At the same time these transformations have some specific features for lower or higher levels of the systemogenesis Thus the turbellarians still practise the "protozoan" way of evolution based on the development of cells with complicated organelles (the extrasomal cells, then paracnids etc). But they also show a purely metazoan mode of evolution based on the formation of the cellular complexes (development of polycellular organs) which then prevails. The Turbellaria show various modes and stages of systemogenesis such as summation effects, the multiple origination and polymerization of organs, segregation of organs and systems, structural systematization and stabilization, oligomerization processes based on reduction, differentiation and concentration of elements As a whole, the Turbellaria give the picture of the beginning morphological diversity and of morphological radiation (Mamkaev 1985, 1986). The same regularities are also observed in other primitive groups and systems So, the regularities observed in the Turbellaria are general regularities of morphological evolution. Such general regularities supply us with certain criteria to distinguish evolutionary primitive and advanced stages. They provide thus a good basis for phylogenetic reconstruction. In this way a reliable methodological ground is obtained for the interpretation of the turbellarian evolution

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ABSTRACTS OF PAPERS

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Utilization of exogenous pyrimidine and purine compounds by growing naeglerias

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Although *Naegleria fowleri*, causative agent of primary amoebic meningoencephalitis, differs from nonpanthogenic *N. lovaniensis* by in vitro resistance to trimethoprim (TMP) and other antifolates (Červa, 1986), properties of dihydrofolate reductase (DHFR), i. e. activity, K_M value and inhibition of the enzyme by TMP, are similar in both species (Čerkasovová and Červa, 1986). We therefore compared capability to utilize precursors of nucleic acids, adenine, adenosine and thymidine by axenicaly cultured naeglerias growing in BCS medium (Červa, 1969). In cell material of *Naegleria fowleri* precipitated by cold 2 % $HClO_4$, the incorporated ^3H-thymidine and ^{14}C-adenosine amounted to approximately 2995 and 119 592 cpm per 10^5 of multiplied cells, respectively, while uptake of these two compounds in *N. lovaniensis* represented only approximately 1675 and 3715 cpm per 10^5 cells respectively. In contrast, capability to employ ^{14}C-adenine was slightly higher in *N. lovaniensis* (99 490 cpm per 10^5 cells) than in *N. fowleri*. Inhibitory effect of TMP on growth of *N. lovaniensis* in the BCS medium was prevented by exogenous thymidine in presence of either adenosine or adenine. The addition of 30—50 nmol ml^{-1} of these precursors partially restored growth of *N. lovaniensis* in presence of 70 nmol ml^{-1} TMP while normal growth curves were obtained at the precursors concentrations 100 nmol ml^{-1}. These results suggest that growth of *N. lovaniensis* in BCS medium in the presence of TMP may depend more than that of N. fowleri on availability of some precursors of nucleic acids, de novo synthesis of which is ceased due to inhibition of the DHFR activity.

The effect of a macrotetrolid complex on the tissue protozoan Sarcocystis dispersa.

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The demonstration of the pathogenicity of several species of heteroxenous *Sarcocystic* coccidia on their hosts, especially those of economic importance (i. e., cattle, sheep and pigs), raised the problem of their control. We have therefore tested a possible antisarcocyst effects of a macrotetrolid complex (MTC) isolated from cultures of *Streptomyces griseus* LKS-1 in the Institute of Microbiology of the Czechoslovak Academy of Sciences This four-component complex of antibiotics is composed of nonactin (4.8%), monactin (20.4%), dinactin (38.8%), and trinactin (36.0%). The antibiotics are soluble in acetone, methanol, ethanol, chlorophorm, and hexan. ,

The druh was administered to infected mice as a water suspension in 10 doses of 2 mg kg body weight In the first part of the experiment, the effect of MTC was observed after the application immediately before infection of white laboratory mice (*Mus musculus*) M_1 and M_2 with *S. dispersa* and during the liver phase of its multiplication. In the second part of the experiment, the drug was administered to M_3 and M_4 mice at the time when mature cyst stages (sarcocysts) were forming in the mouse muscles The control mice, $MK_1 - MK_4$, were infected with *S. dispersa* sporocysts in the dose of 100 000 sporocysts per mouse, like $M_1 - M_4$ mice. but they did not receive the MTC. The experiments were evaluated after the drug administration to M_3 and M_4 had been stopped, i e ten weeks after the beginning. The effect of MTS was evaluated on the basis of the cystozoite number per 1 ml of muscle homogenate from both infected and control mice.

The experiment in which MTC was administered to mice immediately after infection (the drug was applied daily in one dose per day) clearly showed the effect of the drug on the parasites No protozoans were found in muscle homogenates from M_1 and M_2 mice. However, the ten-day administration of MTC at the time when mature sarcocysts occurred in the host muscles did not produce any effect The muscle homogenates contained a similar number of cystozoites as was detected in control MK_3 and MK_4 mice 10—15 millions, to which no MTC was administered

The experiments with the macrotetrolid complex showed that the drug could affect the infection if it is administered together with the parasites However MTC did not produce any effect on muscle sarcocysts. The sarcocysts wall apparently is an effective barrier between the drug and the parasite Consequently, the macrotetrolid complex could be applied only in prophylaxis.

Malate oxidizing enzymes and resistance of Tritrichomonas foetus to metronidazole

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Metronidazole susceptible (KVcl) and metronidazole resistant (KV1-1MR100) strains of *T foetus* were studied with respect to subcellular localization of $NADP^+$ specific malate oxidizing enzymes, e g malate dehydrogenase (E.C. 1.1.1.37) and malate dehydrogenase decarboxylating (E. C. 1.1.1.38, malic enzyme). While specificity of *T. foetus* malic enzyme for both NAD^+ and $NADP^+$ is known, $NADP^+$ specific malate dehydrogenase from this organism is reported here for the first time (activity of malate dehydrogenase was measured as oxidation of NADPH or NADH with oxaloacetate) Homogenates of trichomonad cultures in early stationary phase of growth were subjected to differential centrifugation to obtain nuclear, hydrogenosomal, microsomal and cytoplasmic fraction Each fraction was tested for $NADP^+$ *requiring malate oxidizing activities Specific activities differed substantially* in metronidazole sensitive and resistant strains Main portion of specific malate oxidizing activity in sensitive strain was located in hydrogenosomes (905 mU mgprot $^{-1}$) Relatively high specific activity was observed in nuclear fraction treated with Triton X-100 (386 mU . mg prot $^{-1}$), apparently resulting from contamination of this fraction by hydrogenosomes Activity in microsomal fraction was negligible In the resistant strain main portion of specific malate oxidizing activity was located in cytosol (835 mU . mg prot^{-1}) Specific activity of hydrogenosomal fraction was low (65 mU . mg prot^{-1}) Nuclear and microsamal fractions showed specific activities 121 and 47 mU . mg prot.$^{-1}$ respectively. Cytoplasmic and hydrogenosomal fractions were analyzed by polyacrylamide gel gradient electrophoresis without SDS Histochemical staining for $NADP^+$ requiring malate oxidizing activity showed 7 bands of active enzymes in the cytoplasmic fraction of both the sensitive and the resistant strain. The bands did not differ in electrophoretic mobility, but differences in intensity of enzymatic reaction were found. In the hydrogenosomal fraction 6 and 8 bands of active enzymes were identified in metronidazole sensitive and resistant strains, respectively. Enzymes corresponding with the most active band of electrophoretogram of cytoplasmic fraction from the sensitive strain were partially purified on reactive red agarose chromatographic column. Two active fractions were obtained One of them was active with both malate and oxaloacetate either with oxidized or reduced form of NADP+ (malate dehydrogenase), the second one was active with malate and NADP+ only (malic enzyme). Further studies of NADP+ specific malate oxidizing enzymes in the susceptible and drug-resistant strain are in progress. The results suggest that the metabolic changes underlying the development of metronidazole resistance are accompanied by changes in subcellular localization of NADP+ specific malate oxidizing enzymes.

A contribution to the demonstration of tubulin and actin in the cortex of Paramecium.

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This communication presents a brief review of methods for determination of tubulin and actin in *Paramecium* cells completed with some results obtained by the author in *Paramecium caudatum*. This infusorian has most of its cytoskeletal structures located in the cortex which is responsible for three major biological functions, namely, cell shape determination, locomotion and maintenance of epigenic information.

Tubulin and actin, as structural cytoskeletal proteins, are the bases of microtubules and microfilaments, and can be determined by immunofluorescence, immunocytochemistry, separation techniques and immune electron microscopy. All these techniques show several drawbacks when two necessary requirements are to be met i. e., preservation of the cell structure in a state resembling an in vivo one and presentation of the cytoskeletal structure without interfering effects of the other cellular structures. The prerequisites for meeting these demands are: extraction with non-ionic detergents, permeabilization of cells to facilitate penetration of cytoskeletal markers and fixation of the cell structure, all of them being dependent on the provision of such conditions (ion strength, pH, protease inhibition, reduction of non-specific marker binding) that would ensure optimal reactions. *Paramecium* cells can be handled as other organisms either single or in suspension or organisms attached to a glass. Cytoskeletal structures can be visualized in cells either extracted without fixation or fixed with formaldehyde before or after extraction.

Tubulin in *Paramecium* was demonstrated by indirect immunofluorescence using a primary monoclonal TU-01 antibody and a secondary SwAM-FITC antibody in ciliary axonemas, kinetosomes, transversal and suprakinetodesmal microtubules, in the pore of the contractile vacuole and the radial microtubules of its ducts, in the cytoproct and postoral microtubules of the cytopharynx

Actin was detected with monospecific antibody prepared against actin of *Xenopus* and combined with a SwAR-FITC antibody in the granulofibrilar meshwork, in the close vicinity of kinetosomes, in the pore of the contractile vacuole, in the cytoproct around the oral apparatus and in the epiplasm of the inner alveolar membranes Accumulation of F-actin seen locally in the cytoplasm following mechanical injury of the cell was only transient and disappeared within one hour. The amount of actin in all of these structures was related to their physiological activity.

New aspects in the life cycle of coccidia of the genus Eimeria.

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The present study follows the previous ones dealing with possibility of survival of some *Isospora* coccidia in nonspecific hosts (Frenkel J. K and Dubey J P *J. Infect. Dis.*, 125: 69–72, 1972) and the first reports on this possibility in coccidia of the genus *Eimeria* (Naciri M. and Yvoré P., *C R. Acad. Sci., Paris*, 294 219–221, 1982; **Černá Ž. and Kadlecová M.**, *Věst. čs Společ. zool.*, 53: 71–72

1989). It was of interest to ascertain whether the reported survivals of highly host-specific *Eimeria* in nonspecific hosts were only occasional or whether a more common phenomenon was involved.

Mouse coccidia ***Eimeria ferrisi*** with a very short prepatent period (3–4 days), and goose species ***Eimeria stigmosa***, whose asexual and sexual reproduction takes place in the nuclei, but not in the cytoplasm of host cells, were used as model species for *the studies of the survival of intestinal Eimeria in organs of nonspecific hosts*. Chickens and laboratory rats were used as nonspecific hosts for *E. ferrisi*. The oocysts were administered in the dose of 700 000 sporocysts per animal Homogenates from lungs, liver, spleen, kidney, heart, skeletal muscles, and a part of small intestine were administered perorally to specific hosts, mice, at intervals of 2, 4, 6, and 8 days after infection of nonspecific donors The infection of *Mus musculus* was induced by a material from liver of chickens killed 2 days post infection (DPI) and from the lungs and livers of rats killed 3 DPI Chickens and white laboratory mice were used as nonspecific hosts for *E. stigmosa* We did not manage to transmit the infection to a specific host, gosling, using organs from infected chickens However, the infection was successful if lung and liver homogenates from mice killed 3 DPI were used.

The above results show that the ability to survive in a nonspecific host is a common phenomenon also in *Eimeria* coccidia which may be of importance in epizootology of the infection.

Measurement of oocysts and species differetiation of poultry Eimeria with help of the Leitz T.A.S. PLUS Image-Analyzer.

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The image-analyzer Leitz T.A.S. PLUS, connected with a TV-camera taking picture from Leitz Orthoplan microscope, has been used for semiautomatic measurement of coccidian oocysts with subsequent computer evaluation in order to facilitate species differentiation of poultry *Eimeria* in mixed cultures Parasites observed in phase contrasts were measured directly on computer monitor by actual magnification 500× using a programme during which operator selected objects to be measured by touching end points of oocysts lenght and width with the light pen Data from measurements of fifty oocysts or one hundred ones in cultures suspected to be mixtures of more than three species were graphically analyzed according to oocysts size and shape index of different *Eimeria* species enabled differentiation of morphologically according to their length. The shape was analyzed in diagrams depisting correlation between shape index (the quoitient of length and width) and length of each individual oocyst Comparison of results with the mean values of oocysts length and shape index of different *Eimeria* species enabled differentation of morphologically similar species such as ***E. mitis*** from ***E. acervulina***, ***E. brunetti*** from *E. maxima*, and to a certain level also ***E. tenella*** from ***E. praecox*** and *E. necatrix*. Oocysts of the later two species proved to be very similar and thus hardly distinguishable by the present method.

A new coccidian (Apicomplexa, Eimeriidae) from the dace (Leuciscus leuciscus) and the chub (L. cephalus).

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An undescribed *Eimeria* sp. is reported from the gut of the dace (13 out of 19 specimens infected) and chub (2 specimens infected) from the rivers Malše, Vltava and Blanice, South Bohemia.

Most of the developmental stages were located extracytoplasmaticaly in enlarged microvilli of the gut epithelial cells Oocysts were oval or irregular in shape (14,5–22,0 µm × 11,0–14,2 µm) with the thin oocyst wall closely adhering to sporocysts. Ellipsoidal sporocysts (12,5–14,5 µm × 4,3–5,8 µm) possessed two vermiform sporozoites (10,0–11,5 µm × 2,5–3,1 µm) slightly curved along the sporocyst wall and arranged head to tail. They contained a single oval refractile body and several posteriorly located vacuoles. No oocysts were shed unsporulated. The exogenous sporulation was completed after 48 hours at 10 °C and 20 °C only about $5^0/_0$ and $1^0/_0$ of sporonts sporulated, respectively.

For determination of taxonomic status of this enigmatic parasite further studies on ultrastructure of the developmental stages are needed.

Cloning of a fresh isolate of *Plasmodium falciparum* and drug sensitivity characterization of clones.

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Cloning of freshly isolated *Plasmodium falciparum* strain from Cameroon was performed by limiting dilution using a coculture of infected erythrocytes on monolayers of functionally active roted hepatocytes. RPMI 1640 supplemented with 10% foetal human serum, insulin, bovine serum albumin, corticoides, D-glucose, HEPES and antibiotics was used in all experiments. 1% clones were isolated from one fresh isolate. Antimalarial activity of chloroquine, quinine, mefloquine and halofantrine against clones, the original isolate and culture-adapted isolate was determined using a 48 hour radioisotope microdilution method. The multiplication rates of all clones and culture-adapted isolates in asynchronous and synchronous culture were estimated in thin smears. Variations found in drug sensitivity and multiplication rate of different clones provide a strong evidence of heterogeneity in a single strain parasite population. No morphological variations could be found by light microscopy. The use of a hepatocyte feeder layer and human foetal serum improves the growth of cloned parasites and make it possible to clone directly fresh isolates from a patient. Nevertheless, this technique does not permit the preservation of the whole pool of fresh isolate clones.

Occurrence of *Blastocystis* sp. in pigs

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Blastocystis sp. was recorded in 343 from 416 pigs examined (82,5 %). No significant differences were noticed in the prevalence of *Blastocystis* in pigs of different age, except for piglets up to 2 days of age, in which *Blastocystis* sp. was not present.

Blastocystis sp. from pigs was cultivated in a modified Boeck-Drbohlav egg slant biphasic medium, which is the best diagnostic method. Granular and vacuolar forms appeared in the cultures. The abundance of granular forms decreased with number of passages and with the age of culture in each passage.

Both granular and vacuolar forms contained a large central body and a peripheral cytoplasmic layer with nuclei, endoplasmic reticulum and numerous mitochondria. The width of the intramembraneous space between inner and outer membranes of the nuclear envelope was uneven, in some regions the intramembraneous space was relatively narrow and in the opposite regions it was expanded. The mass of the central body was electronlucent in the vacuolated form, and electron dense with electronlucent granules sometimes containing electron dense centre in the granular form. No significant differences were observed in the ultrastructure of *Blastocystis* sp. from pigs and *Blastocystis hominis* from humans.

Adult outbred laboratory mice were successfully infected with stages of *Blastocystis* sp. from faeces as well as with culture stages.

Cochlosoma — an unusual trichomonad with adhesive disc

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Cochlosoma anatis Kotlán, 1923 is an asymetrical uninucleate flagellate inhabiting large intestine of various, mostly aquatic birds. Systematically, the genus *Cochlosoma* belongs to the family Cochlosomidae Tyzzer, 1930 of uncertain taxonomic position. Some light microscopic features suggested that these organism might be related to trichomonads (Kulda and Nohýnková, 1978). Our electron microscopic studies proved homology of *Cochlosoma* organelles to those of trichomonads at the ultrastructural level. The cochlosomid cell possesses: 1. An undulating mebrane with a distal marginal lamella similar to that of the subfamily Trichomonadinae. 2. A trichomonad-like mastigont with kinetosome of the recurrent flagellum being in perpendicular position to kinetosomes of anterior flagella, sigmoidal lamellae and parabasal fibril associated with kinetosome 2, a B-type costa supporting the undulating membrane, and microtubular pelta and axostyle. 3. A parabasal apparatus composed of Golgi cisternae and striated parabasal fibril 4. Microbody-like double membrane bound organelles similar to hydrogenosomes. The adhesive disc of *Cochlosoma* does not show any structural homology with that of *Giardia* It is based on modified microtubules of pelta each bearing an arm of 9 tubular structures 8 nm in diameter. Our observations of ultrastructure of *Cochlosoma* give evidence that the organism belongs into the order Trichomonadida We propose that the cochlosomid flagellates retain their family status within this order

Lyophilized antigen from Plasmodium falciparum for serological diagnostics of malaria

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Malaria diagnostic by indirect fluorescent antibody test IFAT is widely used mainly for epidemiological purposes. Antigen usually prepared from continuous culture of *Plasmodium falciparum* has to be stored at −20 °C or below. This report describes briefly our results concerning preparation and use of lyophilized antigen.

The antigen was prepared from *P. falciparum* clone T9/96 isolated in Thailand. The parasites were cultivated continuously using modified "candle jar" method (Trager and Jensen, 1976) Nonsynchronized culture with parasitaemia exceeding 7% (mostly schizonts) was washed 3 times with normal saline by centrifugation (627 × g). After the final washing the pellet was resuspended in 1% Ficoll in normal saline (v/v). Aliquotes of 1 ml were filled into glass lyophilization ampoules and processed in a lyophilization apparatus KF-30 for 48 hours at 25 °C. The lyophilized antigen was stored at 4 °C and 35,5 °C, respectively, for at least two months without any loss of its activity

One hundred and fifteen serum samples from patients living in malaria endemic regions were examined using both lyophilized and cryopreserved antigen of *P. falciparum*. Nearly perfect correlation between both antigens was found. Only few sera gave titres varying more than in one dilution.

The possibility to maintain the lyophilized antigen at 4 °C, at room temperature or in tropical climate conditions for at least two months is the main advantage of this antigen preparation Its use will favorize the standardization of serological studies and distribution of antigen in the field conditions This could be particularly important in epidemiological surveys evaluating the effect of future antimalarial vaccine.

Trichomonas vaginalis: Aerobic resistance to metronidazole induced in vitro.

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The aerobic type of resistance of *Trichomonas vaginalis* to metronidazole was induced in vitro by cultivation of trichomonads in the presence of low concentrations of metronidazole under anaerobic conditions. A cryostabilate of the strain TV 10-02, susceptible to the drug, was inoculated into the Diamond's TYM medium containing 1 μg/ml metronidazole and maintained by daily transfer for 12 weeks During this period the drug pressure was increased in two steps to 2 and 3 μg/ml Trichomonads that gained the ability to grow at 3 μg/ml metronidazole under anaerobiosis proved to be resistant to high concentrations of drug in the presence of oxygen Susceptibility assays with these organisms performed on microtitre plates (Meingassner's method) under aerobic conditions showed minimal lethal concentration (MLC) after 48 h exposure to the drug averaging 216 μg/ml metronidazole The values of anaerobic MLC for these organisms were rather low 6.25 μg/ml but higher than those for the parent strain determined both under aerobiosis 4,8 μg/ml or anaerobiosis 1.65 μg/ml Incubation of susceptibility assays in defined gas mixtures (N_2 with 5% CO_2)containing different concentrations of O_2 (1—20%) proved that the manifestation of the resistance is oxygen dependent The threshold concentration of O_2 at which the marked increase of MLC occurred was 5% (MLC = 126 μg/ml.) Resistance of the in vitro developed strain was confirmed in vivo using ICR mice inoculated subcutaneously. The dose of metronidazole needed to cure 50% of mice (DC_{50}) infected with the resistant organisms (DC_{50} = 216 mg/kg × 3) was 35 fold higher than that needed to cure mice infected with drug susceptible parent strain (DC_{50} = 6.5 mg/kg × 3).

Our results show that an aerobic type of resistance to metronidazole, similar to that occurring in clinical isolates of *T. vaginalis* from patients nonresponsive to standard treatment, can be developed in vitro The fact that the resistance can be induced by relatively low concentrations of drug is disturbing with regard to a possibility of appearance of drug resistant *T. vaginalis* consequently to an inappropriate metronidazole regimens in patients.

Indicator value of freshwater Vaginicolidae (Ciliata, Peritricha).

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Fourteen species of freshwater family of Vaginicolidae were classified as indicators of saprobity. The saprobic valence in 10 balls for 5 levels of limnosaprobity x = xeno- o = oligo-, b = beta-meso-, a = alpha-meso-, and p = polysaprobity, the indicative weight of species I_i and the individual saprobic index S_i were given. During the last two decades there is a striking adaptation of some species to the new environmental conditions, i. e. increasing organic pollution and eutrophication, so that several species can be found even in the activated sludge and other modes of the biological purification.

Taxon	x	o	b	a	p	I_i	S_i
Cothurnia annulata Stokes	—	6	4	—	—	3	1.4
Cothurnia imberbis Ehrenberg	—	—	4	6	—	3	2.6
Platycola longicollis Kent	—	8	2	—	—	4	1.2
Platycola truncata Fromentel	—	2	4	4	—	2	2.2
Pyxicola affinis Kent	—	8	2	—	—	4	1.2
Pyxicola socialis Gruber	—	—	6	4	—	3	2.4
Thuricola folliculata O F Muller	—	2	6	2	—	3	2.0
Thuricola kellicottiana Stokes	—	2	7	1	—	3	1.9
Thuricola similis Bock	—	—	—	10	—	5	3.0
Thuricola vasiformis Hammann	—	—	—	10	—	5	3.0
Vaginicola crystallina Ehrenberg	—	—	5	5	—	3	2.5
Vaginicola ingenita O. F. Muller	—	—	6	4	—	3	2.4
Vaginicola striata Fromentel	—	—	2	8	—	4	2.8
Vaginicola tincta Ehrenberg	—	5	5	—	—	3	1.5

Determination of viability of Giardia intestinalis cysts.

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Three methods used for determination of viability of *Giardia intestinalis* cysts were compared

1. In vitro excystation method after Bingham (1979).
2. Eosin staining method.
3. Fluorogenic staining method with fluorescein diacetate and propidium iodide (PI) after Schupp and Erlandsen (1987). The experiments were carried out with 6 samples of cysts obtained from fresh feces of 5 humans Cysts were purified by sucrose gradient centrifugation, adjusted to concentration 1×10^6 cysts per ml and stored at 5 °C until used. The samples were assayed in parallel by above three methods in 7 days intervals until depletion of cysts.

The results can be summarized as follows Using eosin and fluorogenic staining methods characteristic differencies in viability of the cysts were found among the samples which remained unchanged for several weeks. Different samples obtained from the same person showed also different percentage of viable cysts. The percentage of cysts capable to excyst was consistently lower and not in a good correlation with percentage of viable cysts detected by means of staining methods. Proportion of excysted cysts increased within the first two weeks after their isolation and declined thereafter. Few cysts, however, retained their excystation ability over one year. A good agreement was observed and statistically confirmed in detection of non-viable cysts by staining with eosin and PI. Non-viable cysts could also be recognized morphologically. Estimation of viable cysts using fluorogenic dyes revealed subpopulation of unstained or black cysts representing in different samples 0—90 % of total number of the cysts. The black cysts did not change their colour even after restaining or repeated staining.

In conclusion: Application of staining methods can indicate viability of cysts in each sample of *Giardia intestinalis* cysts. Part of the population judged to be viable by staining methods can be induced to excyst in vitro. There is, however, always a significant proportion of cysts in the sample which appear to be viable by staining methods but are unable to excyst.

Enzymatic analysis of culture forms of fish trypanosomes

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Sixteen strains of trypanosomes were isolated from blood of 10 species of freshwater fish all but one being captured in ponds and rivers of South Bohemia (*Esox lucius, Rutilus rutilus, Scardinius erythrophthalmus, Abramis brama, Blicca bjoerkna, Tinca tinca, Carassius auratus, C. carassinus, Cyprinus carpio,* and *Perca fluviatilis*). The strains were characterized by enzymatic analysis using disc electrophoresis on 5% acrylamide gel. For the analysis, six enzymes (ADH, LDH, MDH, ME, G6PDH, and GPI) were selected, because their respective activities exceeded the putative limit of sensitivity of the system employed (0,080 μmol ml^{-1} min^{-1}). The most variable enzymes were ADH and LDH (7 and 6 enzyme patterns, respectively), whereas MDH, G6PDH, and GPI showed the same pattern in all analysed strains.

The cluster analysis indicated a very high degree of similarity among analysed strains, even among those isolated from phylogenetically distant hosts. Moreover, no correlation between enzyme pattern and host species was found.

Serodiagnosis of amebiasis.

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The combination of two serological methods, both sensitive and specific, is recommended to compare the presence of antibody titres in sera from patients with extraintestinal amebiasis. In this study, indirect hemaglutination (IHA) and indirect fluorescent antibody method (IFAT) were compared.

For IHA, commercial kit for serodiagnosis of amebiasis from Behring (Amebiasis, Reagent Kit) was used. For IFAT, trophozoites of two strains of *Entamoeba histolytica* originally isolated in agnotobiotic cultures from asymptomatic cysts carriers were used to prepare antigen. Briefly, the trophozoites fixed in 1% (v/v) neutral formaldehyde-PBS (pH 7.2) for 1 hour were washed three times with PBS (pH 7.2). The trophozoites suspension was dropped on glass slides and dried at 20 °C. Antigen preparations were then stored at − 20 °C until used. Serum samples collected for 5 years were obtained from 255 foreigners comming from areas endemic for amebiasis and 401 Czechoslovak returneers from abroad. Most of the patients were symptomatic with symptoms similar to those of either intestinal or extraintestinal amebiasis. An IHA test was performed directly according instructions of Behring. Sera for IFAT were diluted with PBS (pH 7.4) starting from 1 : 16 dilution.

Examination of 656 sera for antibodies to *Entamoeba histolytica* by IHA and IFAT revealed 54.1% to be negative and 6.1% positive by both techniques, 6.0% negative by IHA, but positive by IFAT, 13.7% positive by IHA, but negative by IFAT. IHA gave higher antibody titres in 18%, while IFAT in 2% of sera examined. 26.2% of sera from Czechoslovak citizens and 47.5% of sera from foreigners were positive in

IFAT, while IHA gave positive results in 26.2% of Czechs and 60.8% of foreigners Post-therapeutical reexaminations of serum samples of 7 humans within intervals of one, two and five months proved the persistence of serum antibodies mostly of the same antibody titres.

It is evident that negative results of serological methods cannot exclude presence of *Entamoeba histolytica* cysts in large intestine. Serological tests are therefore of value for detection of invasive amebiasis mainly.

Ultrastructure of the spore of Nosema otiorrhynchi.

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The microsporidian *Nosema otiorrhynchi* Weiser was described in 1951 from the Malphigian tubules and the fat body of adult snouth beetles *Otiorrhynchus ligustici* At the time it was a pest of alfa alfa and sugar beet, in recent years it is a serious pest of hops The material was from a single infected beetle collected in the spring of 1989, the infected Malphigian tubules were fixed with glutaraldehyde and OsO_4 in cacodylate buffer and embedded in Vestopal W. Ultrathin sections were stained with uranyl acetate and lead nitrate and inspected in the JEOL JEM 100B electron microscope.

Elongate oval spores measured in fresh mounts $3.8-4 \times 1.8-2\ \mu m$. On sections they have a thin electron dense exospore and a rather thick ($0.4-05\ \mu m$) transparent endospore. On sections there are 8—10 cross sections of the coiled polar filament which is isofilar $0.2\ \mu m$ in diameter. In the posterior pole is a very well formed spongioid posterosome (Golgi). its dense secretion is adherent to the coil of filament The anterior end is filled with a lamellar polaroplast with a minimum of the foamy part. In the central part of the spore is the germ itself. Its nuclear complex with a spherical or oval cross section ($1-1.5\ \mu m$) is enclosed in a net of endoplasmic reticulum in 2—5 continuous layers. In some spores the ribosomes are grouped in bands which cross longitudinally the spore from the polaroplast to the Golgi apparatus. Compared with internal structures of other microsporidia the spore of *Nosema otiorrhynchi* differs in its simple organization of the polaroplast with only the lamellar part and in the basket-like arrangement of the endoplasmic reticulum around the nucleus complex. In mature spores the differentation of the nuclear complex was not possible. Compared with other genera of microsporidia, the electron dense exospore is thin and smooth The coil of the polar filament in the posterior part is oblique (up to 45°).

Jefferies, R. P. S., 1986: *The Ancestry of the Vertebrates*. British Museum (Natural History) Publication, London, 376 pp.

Professor Jefferies, a palaeozoologist in the British Museum's natural history department, works on the phylogenesis of vertebrates on the basis of the "calcichordate theory", which has originated in the author's study of rich fossil material from this group, so far mainly considered to be Echinodermata of the class Carpoidea. Though the Calcichordata have many features of the Chordata, they preserved a calceous shell similar to that of the echinoderms. They lived from the middle Cambrian to the middle Devonian, i.e. roughly from 600 to 400 million years ago. Much of the material comes fro mthe Bohemian Ordovician in Czechoslovakia (the author in his introduction expresses his thanks to two Czech scientists).

On the basis of dozens of his papers on this group and a description of many new species, the author then formulates and verifies from all feasible points of view his calcichordate theory, with regard to all available findings in palaeontology and evolution of chordates, in the following ten chapters. 1. Tims, a history of research and methods and methodology of the work. 2. The relations between multicellular organisms, Hemichordata and Echinodermata. 3. Extant Acrania, Amphioxus and its relatives. 4. Tunicata. 5. Anatomy of adults and the bases of phylogenesis of living vertebrates. 6. Embryology of mammals and the problem of the head. 7. Stem chordates — Cornuta. 8. Primitive crown chordates — Mitrata. 9. Phylogenesis of deuterostomes. 10. Some other opinions.

The main part of the book consists of a careful analyses of morphological characters and an attempt to homologise them with identical or similar characters of the Chordata. In this homologisation the greatest role is of course played by the most typical characters of the chordates, i.e. the chorda dorsalis and the branchial slits. The class Calcichordata is divided by the author into two orders: Cornuta with external branchial slits on the left side only, and Mitrata, with pairs of branchial slits. The Cornuta, known as early as the lower Cambrian, are considered to be the more primitive, and there is thus an apparent paradox, the unilateral gills being of earlier origin than the paired gills of the Mitrates, which come from palaeontologically younger finds. But the author supposes that the Cornuta developed from a "dexiothetic" ancestor, which was a descendant of the pterobranch type of creature of the Celphalodiscus type. So the original symmetry gave way, in connection with a pelagic way of life, to asymmetry, which led on the one hand to the echinoderms and on the other to the chordates.

Jefferies also supposes the presence of a dorsal chorda, which in Calcichordata stretches from the cephalocaudal junction to the caudal end of the tail. While in the Cornuta it is in the ventral groove of the skeleton, in Mitrata it lies dorsally. In the middle of the chorda, according to the author, there was probably a longitudinal vessel. The localisation of the chorda also gives rise to the author's attitude to the head problem. He evaluates the views of the segmentalists and antisegmentalists, and himself takes the view that vertebrates developed from a type of ancestor on the level of the larva of tunicates with a clearly distinguishable head. He admits the possibility of the segmentalists view being right to some extent, however, in that there may be a relation between the muscular segments and the branchial slits.

The book contains many more discutable views, such as the question of the participation of the entoderm in the construction of the hypophysis, the strict division of multicellular organisms into Protostomia and Deuterostomia, etc. In spite of the author's very well founded views, documented with rich palaeontological material, one cannot by any means consider the calcichordate theory to be generally known and accepted, though it is a great deal better justified than the other views on the origin of vertebrates (Hemichordata, Tunicata, Ceriantha, etc.). But this is a question which does not concern the level of the author's conception itself. It is well known that such wide-ranging basic theories take an average of twenty years to be accepted and spread at least.

The significance of **Jefferies'** book and its scientific value lie not only in its formulation and development of a new theory of the origin of vertebrates, but also in the fact that the book presents a general review of the problem from all its possible points of view, and can also be used as a textbook of the methodology of the evolutionary approach. Though the author subscribes to somewhat one-sided Hennig's cladism, the use of which he deals with in detail in the introductory chapter, in fact he goes much further, and uses to the same extent all available knowledge from other branches of biology (zoology) in the spirit of the title of his book, for a thorough synthesis of the current state of knowledge on the origin of vertebrates.

V. J. A. Novák, J. Slípka

Holcik, J. ed.: *The Freshwater Fishes of Europe*. Vol. 1, Part II, *General Introduction to Fishes Acipenseriformes.* Aula-Verlag Wiesbaden, 1989, 469 pp., 63 figs., 78 tabs. Price 236,– DM

The work "The Freshwater Fishes of Europe represents a series of 9 volumes, which will be stepwise published by Aula-Verlag Wiesbaden. Vol. 1 (J. Holcik) was divided into two Parts. Part II was prepared by J. Holcik with a group of 12 authors.

Part II includes two essential sections as follows: A. General Introduction to Fishes (pp. 118–147) written by J. Holcik (Chapters 1–4 and 7), P. Banarescu (Chapter 5) and D. Evans (Chapter 6) and B. Systematic part – Acipenseriformes (pp. 148–469) with contributions by L. S. Berdichevskii (+), J. Holcik, A. V. Pavlov, M. I. Pirogovskii, A. S. Popova, T. N. Shubina, L. I. Sokolov, E. T. Tortonese (+), V. P. Vasil'ev, and A. D. Vlasenko.

In General Introduction to Fishes, the authors compiled all the important and current data on the morphology, determination criteria, reproductive strategy and ontogeny about fishes and their environment, zoogeography and history of the freshwater fish fauna of Europe and aspects of the conservation of European freshwater fishes. This part is completed by a simple key to particular families of European freshwater fishes and by references.

In Section B. Systematic part – Acipenseriformes, the order Acipenseriformes and family Acipenseridae are characterized, including keys to families, subfamilies and genera and their particular representatives (total of 9 species) of two European sturgeon genera (*Huso* and *Acipenser*) are discussed. For easy orientation in the text and classification of knowledges, each species is treated in a uniform manner with considering the following topics: synonyms, holotype, etymology, description (morphology, karyotype, protein specificity, osteological characteristics, sexual dimorphism, variations, age and size variability, subspecies, hybrids), distribution (introduction), ecology (habitat, migrations, hardiness, feeding habits, longevity, growth, population dynamics), reproduction biology (maturity, gonads, spawn, spawning period, spawning sites, mating habits, spawning habits, early ontogeny), important parasites and diseases, economic importance and literature. Thanks to this arrangement of the text, it is easy to compare data for particular species and also to locate still existing gaps in the current knowledges.

The whole work is complemented by excellent drawings by M. Baradlai of morphological structures and detailed drawings of one representative for each genus (*Huso huso* and *Acipenser sturio*), however, I believe that in a work of this type, drawings should be presented for all the species and not only for the selected representatives of the genera.

The first as well as second parts of the work are complemented by extensive lists of the literature, particularly in the Systematic parts, which presents, in addition to known works, many less known works of a regional importance. The work is terminated by an index of scientific names of the order Acipenseriformes and index of common names of sturgeons (vernacular names).

It is to conclude that J. Holcik and coauthors met with success in writing a work, which is the most complete treatise as to its content and extent dealing with the given problem in the European ichtyological literature. It summarizes data from a number of authors, with their critical classification and evaluation. In this way it provides a comprehensive treatise on the group Acipenseriformes with indicating certain topics, insufficiently studied in the past, where the knowledges are either incomplete or missing. The work has been accomplished thanks to the cooperation of a number of icthyologists from different countries and it can serve as an example for future publications in different branches of zoology.

I am sure that the work will be useful for all the ichtyologists and further specialists in European countries as well as throughout the world and that it will bring a contribution to a further development of ichtyology.

M. Švátora

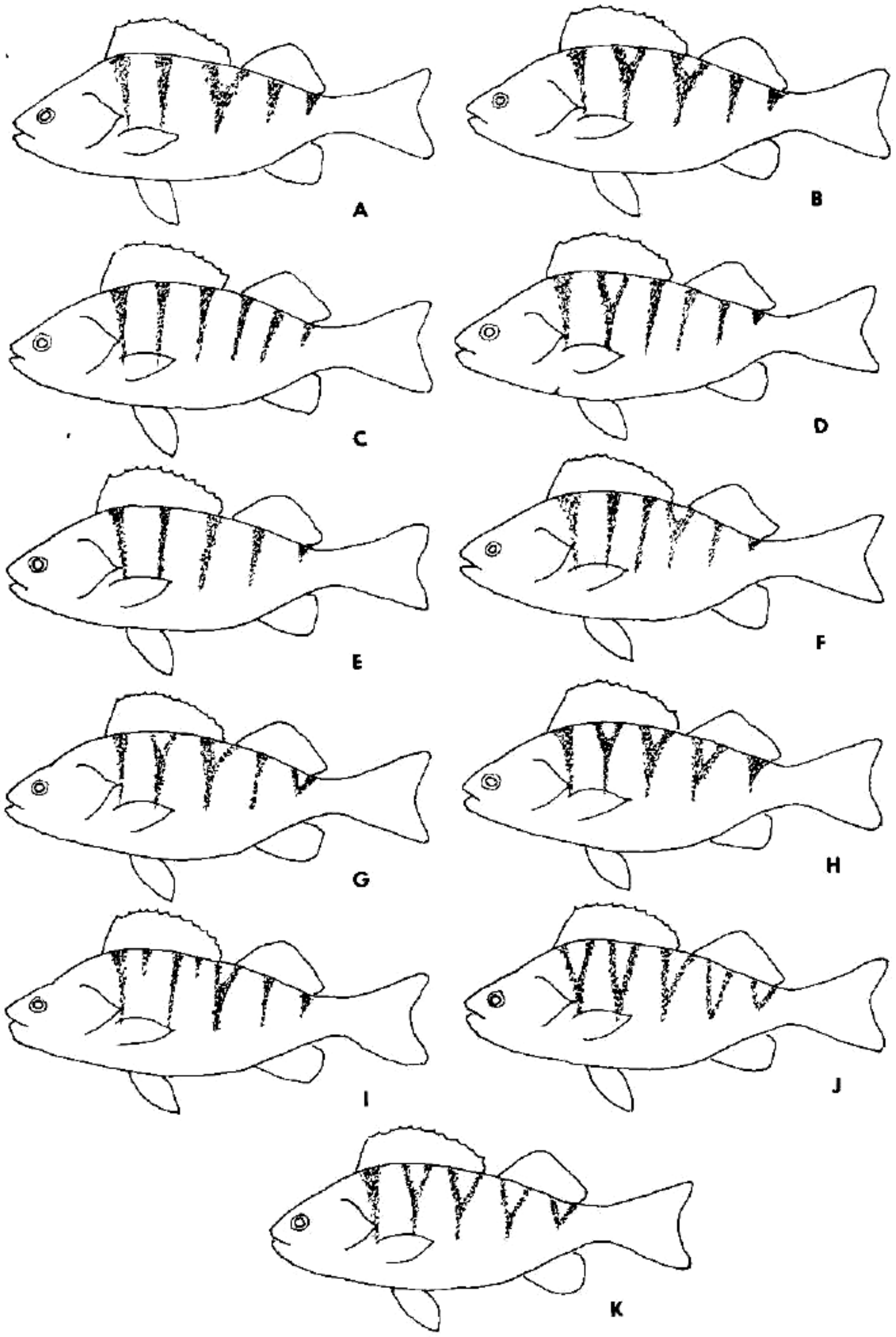


Plate I, Figs. A – K. Different types of coloration in the perch from the Slapy artifitial lake see text).

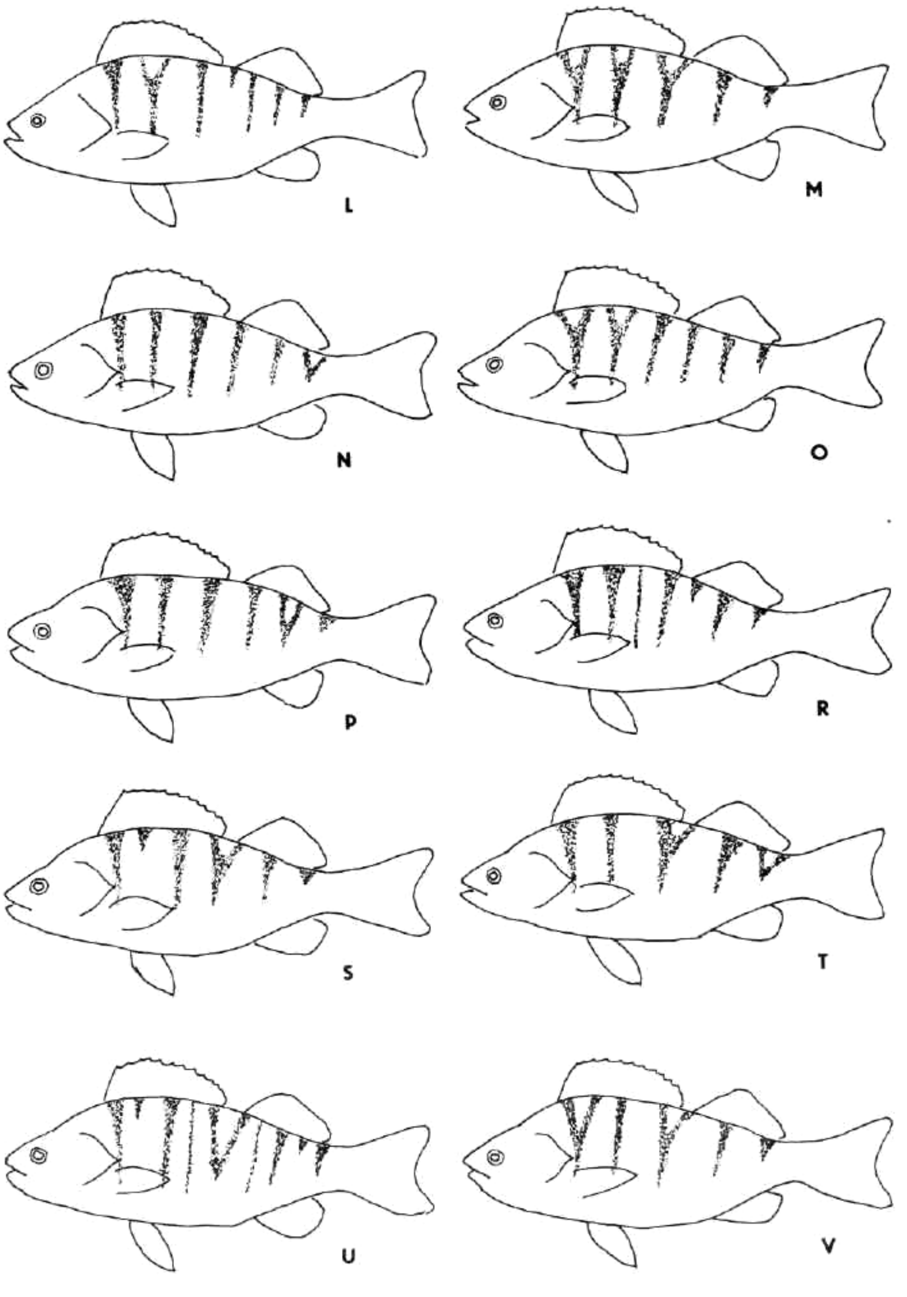


Plate II, Figs. L—V. Different types of coloration in the perch from the Slapy artifitial lake (see text).

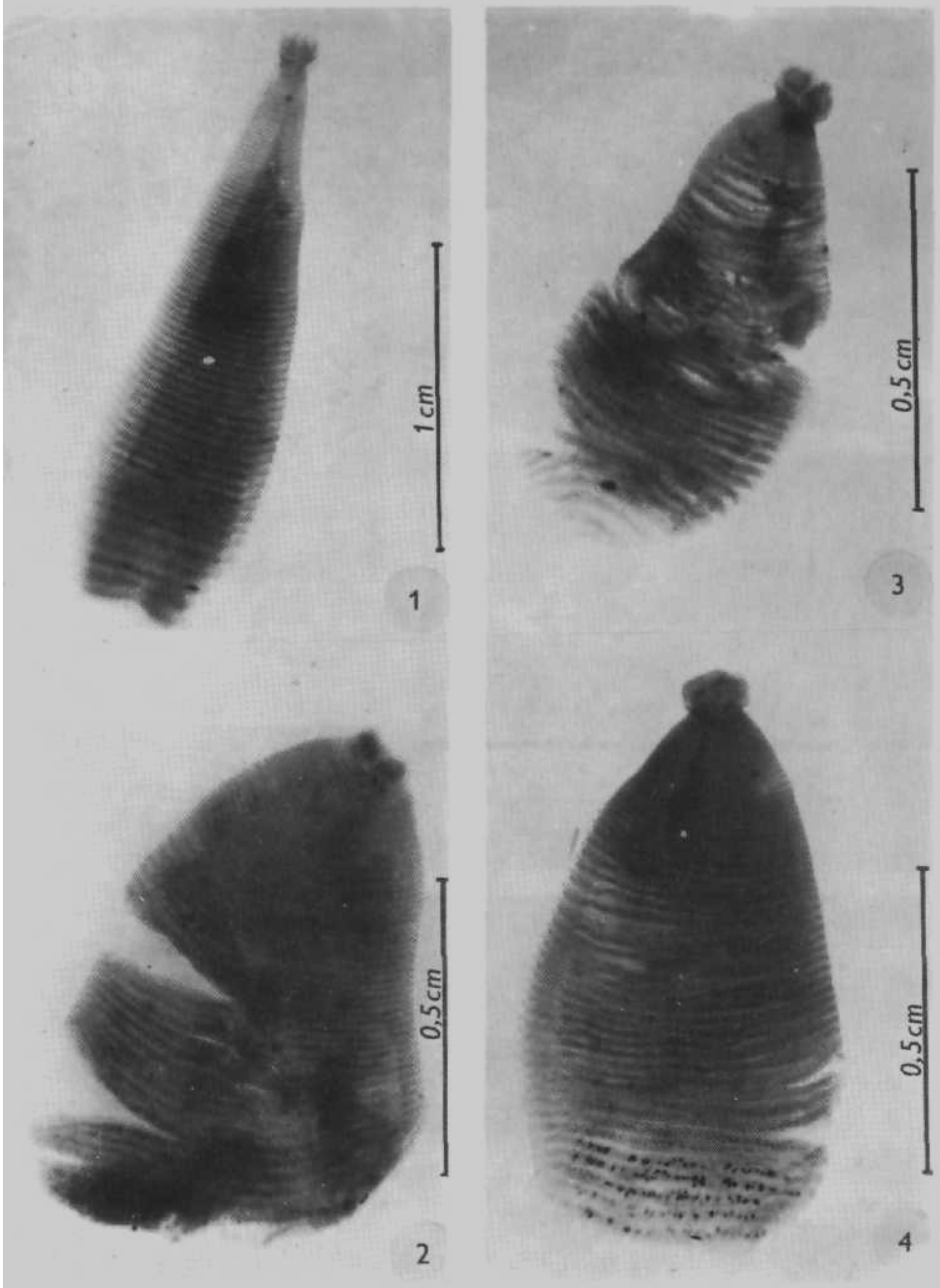


Plate I., Fig. 1: *Paranoplocephala lemmi* Rausch, 1952, foto, holotypus, total view. Fig. 2—4: *Anoplocephaloides lemmi* (Rausch, 1952), total preparations, foto. Material from Taimir, host *Lemmus sibiricus*.

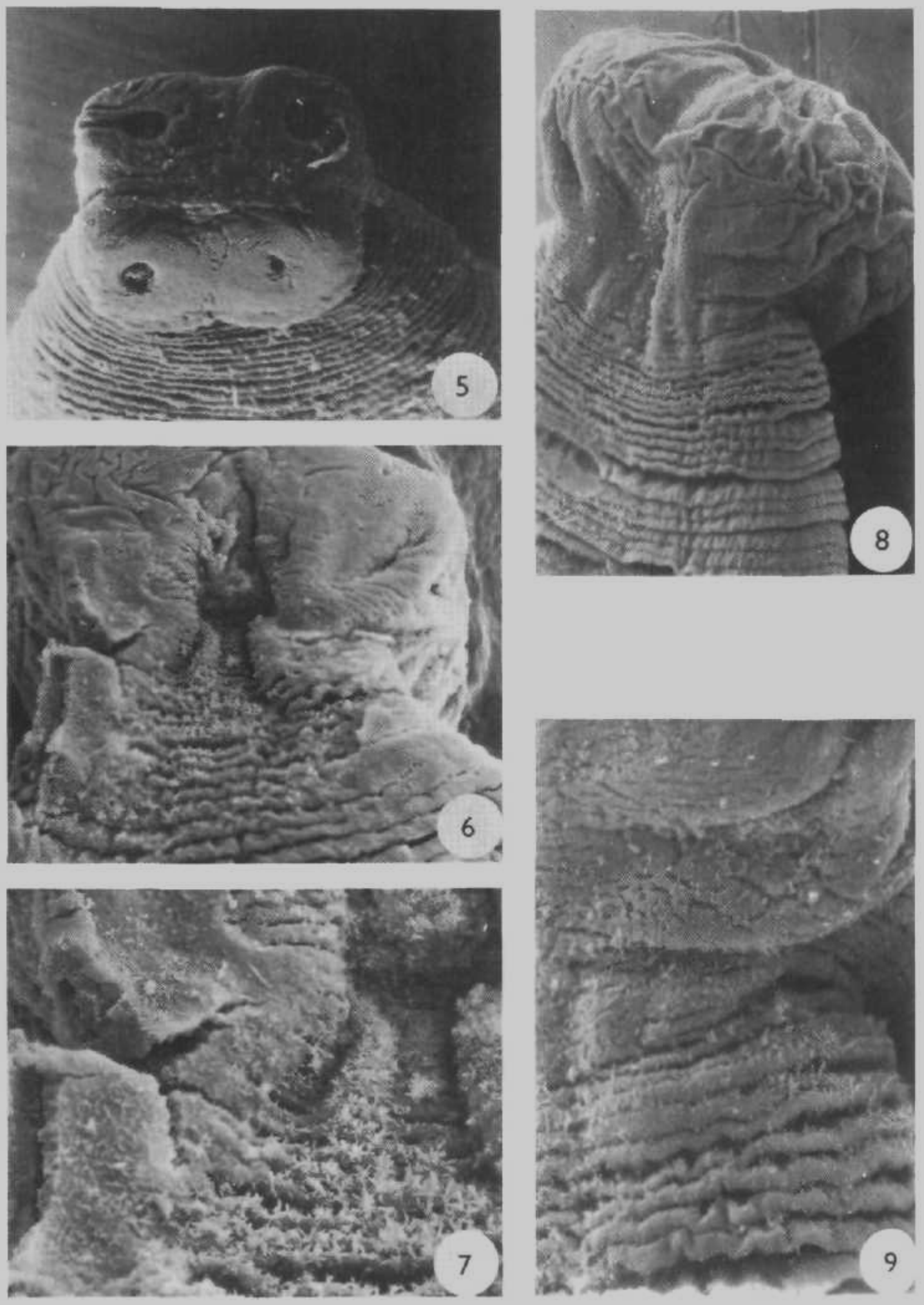
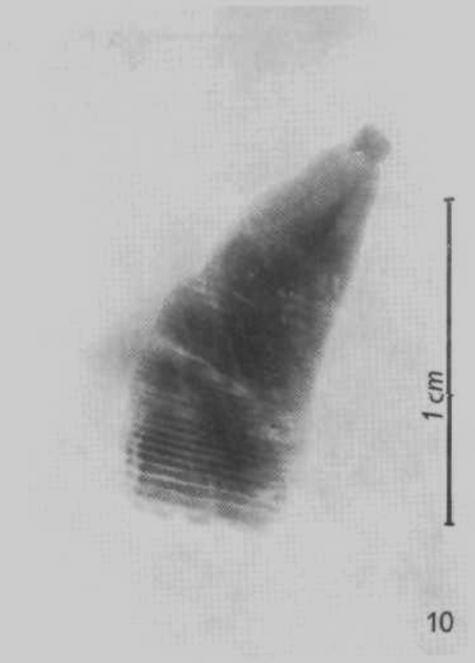
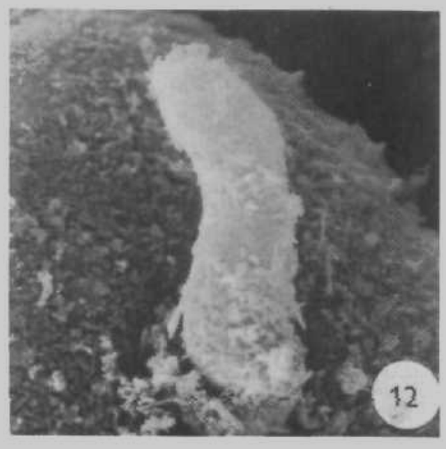
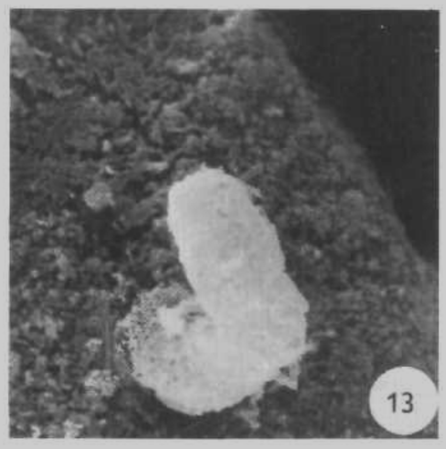
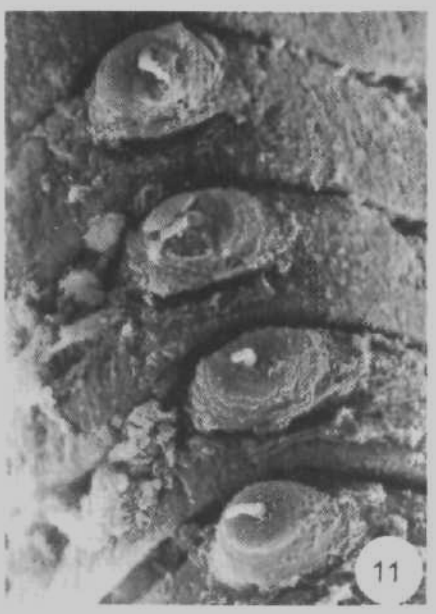


Plate II., *A. lemmi* (Rausch, 1952), SEM. Fig. 5 — scolex and the part of strobila, × 100. Fig. 6 — scolex and the part of strobila, ventral, × 240. Fig. 7 — the part of scolex and strobila, detail, × 530. Fig. 8 — scolex and strobila, × 180. Fig. 9 — the part of scolex and strobila, × 500.









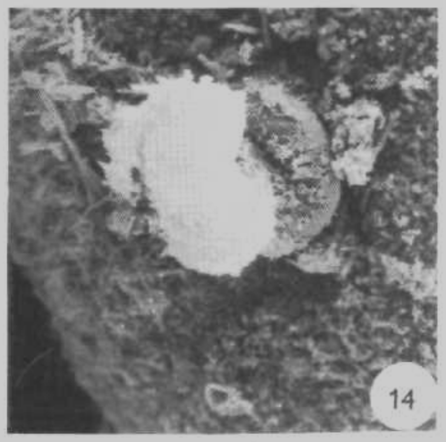
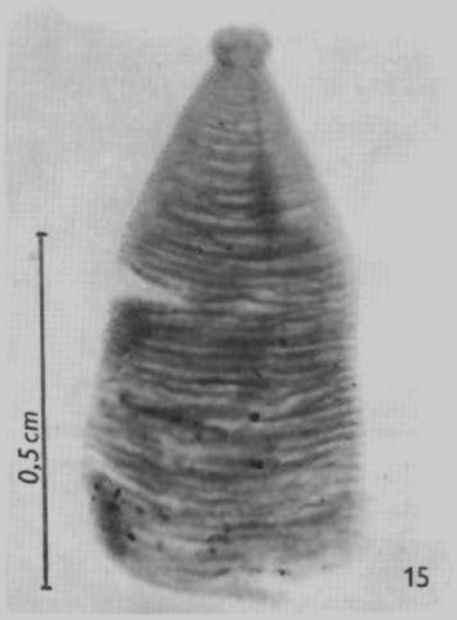


Plate III., *A. lemmi* (Rausch, 1952). Fig. 10 – total view, foto. Fig. 11–14, SEM. Fig. 11 – opening of genitalia, × 300. Fig. 12, 13, 14 – different types of not spiny cirrus, × 3000.



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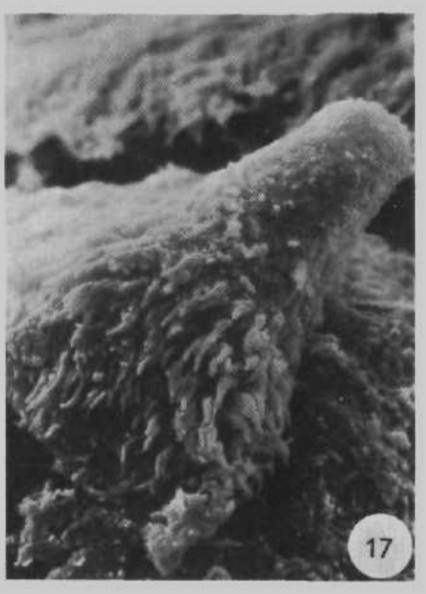

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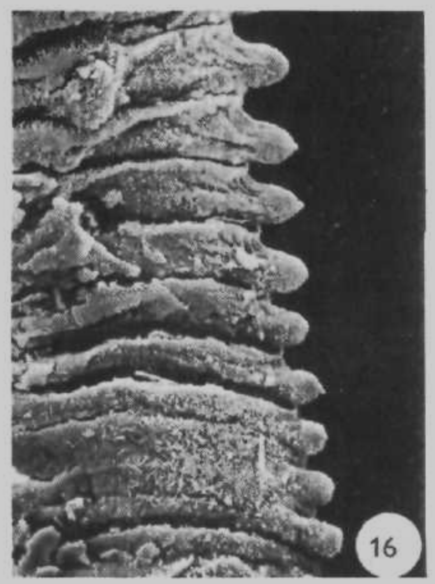

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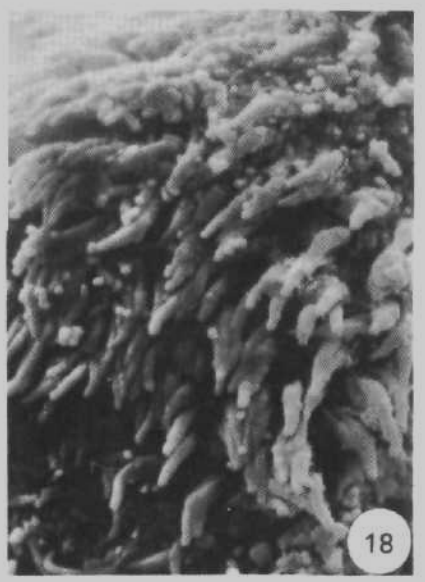

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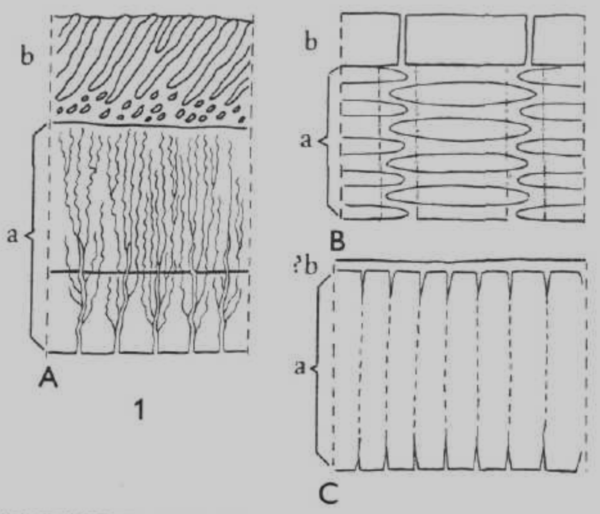
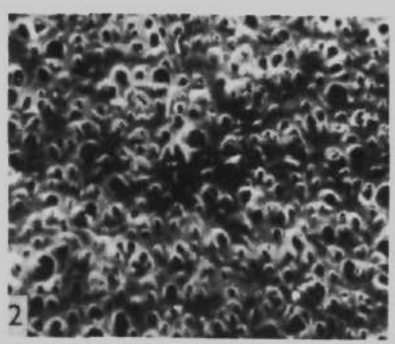
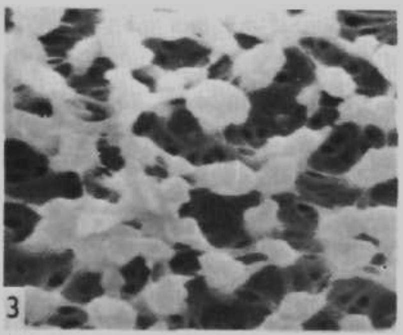
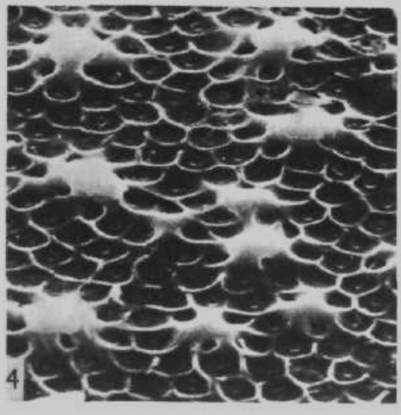
Plate IV., *A. lemmi* (Rausch, 1952). Fig. 15 — total view, foto. Fig. 16—18, SEM. Fig. 16 — part of strobila, × 150. Fig. 17 — cirrus with spines, × 5000. Fig. 18 — spines of cirrus, × 10 000.









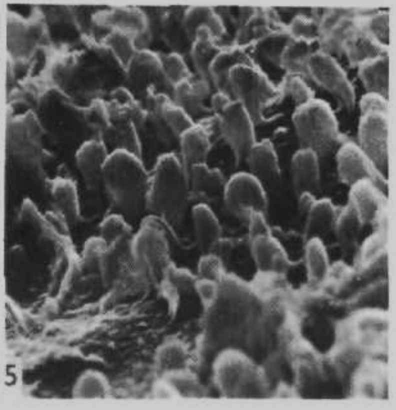
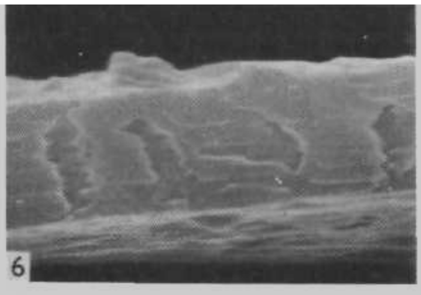


Fig. 1. Types of egg membranes in fishes (A — *Acipenser*, B — *Cyprynus*, C — *Salmon*, a — zona radiata, b — chorion). Fig. 2. Surface of the egg membrane in the sturgeon (*Acipenser gueldenstaedti* Brandt, × 2400). Fig. 3. Surface of the egg membrane in the sterlet (*Acipenser ruthenus* L., × 2000). Fig. 4. Surface of the egg membrane in the sig (*Coregonus lavaretus pidschian* (Gmel.). Plate-like processes × 2000. Fig. 5. Surface of the egg membrane in *Rutilus frisii kutum* (Kamensky), × 6000.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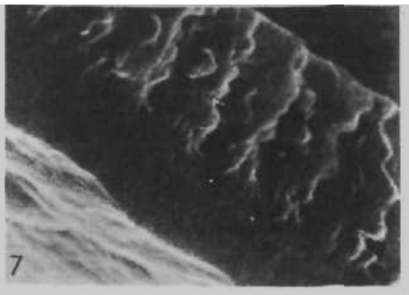
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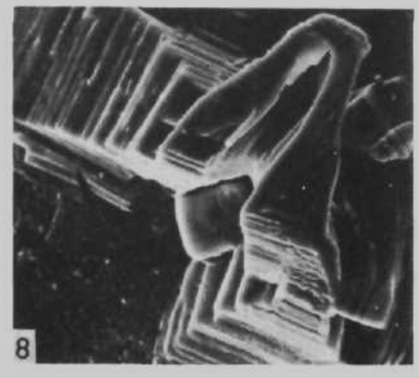
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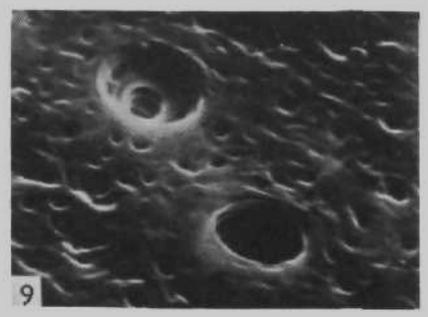
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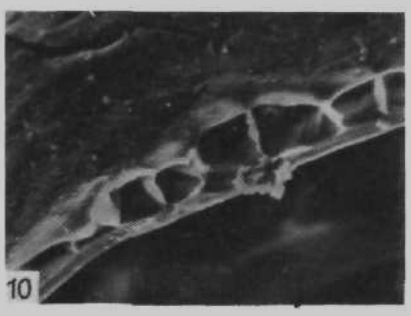
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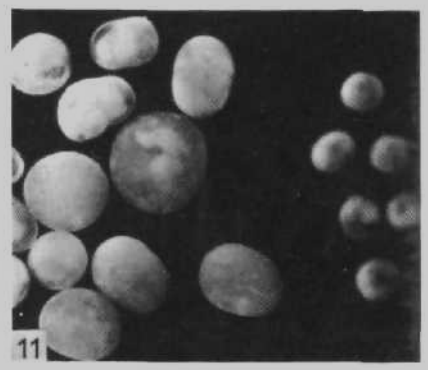
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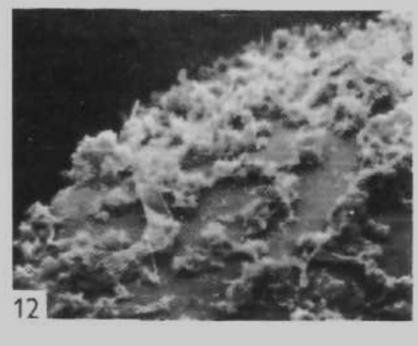
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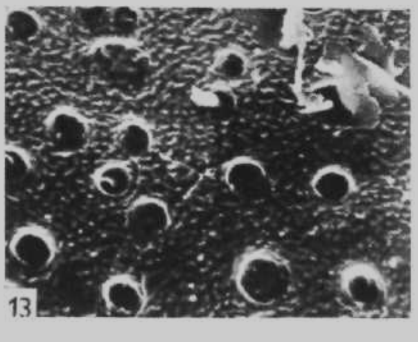
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Fig. 6. Egg membrane in *Cyprinus carpio* L. subjected to carbohydrate food ration as represented the breaking, × 10 000. Fig. 7. Egg membrane in *Cyprinus carpio* L. subjected to protein ration, × 10 000. Fig. 8. Druse on the egg membrane of the place (*Platessa platessa* L.), × 1000. Fig. 9. Large perforations in the egg membrane of the sturgeon (*Acipenser queldenstaedti* Brandt). Pathological case in environment poluted by chemicals, × 3000. Fig. 10. Dissociation and separation of secondary membrane in deadhetised sturgeon (*Acipenser queldenstaedti* Brandt) eggs. Pathological case, × 150. Fig. 11. Eggs of sevruga (*Acipenser ruthenus* L.) normal and those which developed on fresh cement. Enlargement of × 3 is observed. Fig. 12. Surface of egg membrane in *Cyprinus carpio* L. deadhetised by talkum-powder, × 200. Fig. 13. Surface of egg membrane in *Cyprinus carpio* L. after a suden drop in temperature. Canal pores widened, ×

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